Instruction Manual

Model SPL-430
X-Y Digital Plotter

(A3 size)

CONTENTS

1. INTRODUCTION

Thank you for your purchase of our product. Please read this manual thoroughly to obtain the best performance from your plotter for a long time.

This unit is the small-sized pen plotter providing 56 kind of graphic commands and has a capability of A3/B-size and A4/A-size papers. The drawing and printing operation in many colors can be performed according to the drawing command from the various host CPUs. For the plotting method, this unit uses the paper moving system that the paper is moved in perpendicular direction to the moving axis of pen carriage, so that the high-speed drawing is possible.
Included features are described as follows:

(1) Small-sized, light weight desk-top design with simple construction and high reliability.

(2) 400 mm/sec in axis direction, 565 mm/sec in composite direction with an acceleration of more than 1G: High-speed drawing is realized.

(3) High-quality drawing with 0.025 mm step size.

(4) The plotter is provided with serial interface (conformable to RS232C) as standard and an optional 8-bit parallel (conformable to CENTRONICS) or GP-IB (conformable to IEEE-488) interface.

(5) Provides the graphic language conforming to HP-GL so that the plotter can be operated with various commercially available application softwares.

(6) By adapting 6 pens to the pen carousel, pen selection can be performed automatically by the pen select command for drawing in many colors.

(7) High quality presentation graphics can be drawn on OHP film by using oil base pen.

With these superior features above, we offer the plotter of high cost/performance ratio; for business graphic use, CAD (computer aided designing), laboratory, education (institution) and many other fields.

2. PRECAUTIONS ON OPERATION

Pay attention to the following points for safe operation.

● Avoid leaving the plotter in places exposed to direct sunlight, near heaters or with high temperature for a long time.

● Avoid operating the plotter in dusy or humid places.

● Do not lean on the carriage cover or the writing panel or put a heavy thing on there.

● Avoid operating the plotter in places exposed to extreme mechanical vibration or electric noise.

● Before connecting the plotter plug, be sure to check the supply voltage.

● Connect the plugs and connectors securely. If not, it will cause a malfunction.

● Never lubricate the mechanism. It will cause a trouble.

3. NOMENCLATURE AND FUNCTIONS OF PARTS

3-1. Nomenclature

Pen carousel

Carriage cover

Pen carriage

Paper stopper

Cover

Power switch

Paper loading lever

Pinchwheel

Writing panel

Control panel

Power switch

Input/output connectors

Dip switch

Fuse holder

Power cord
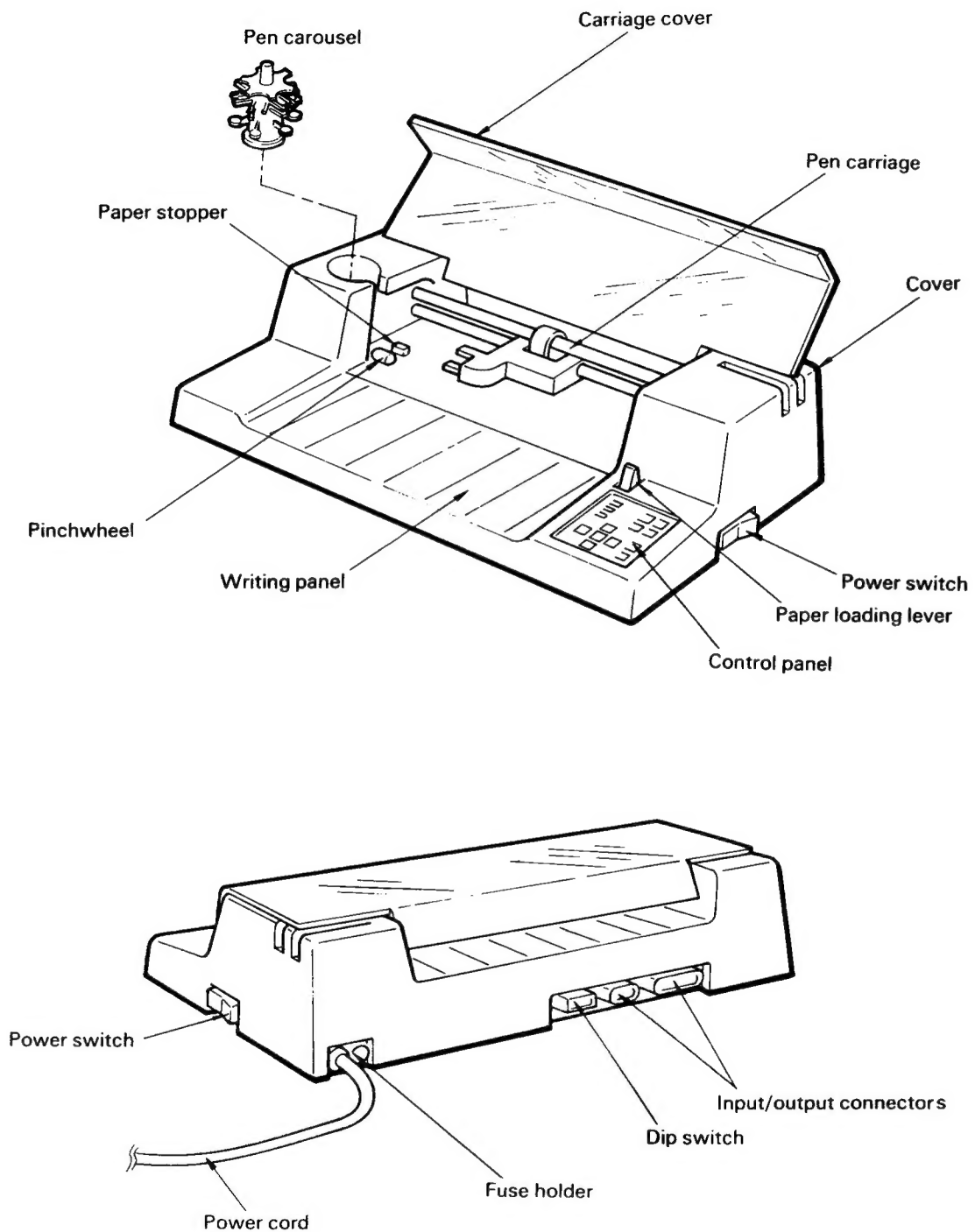
3-2. Standard accessories

Make sure that the following accessories are furnished.

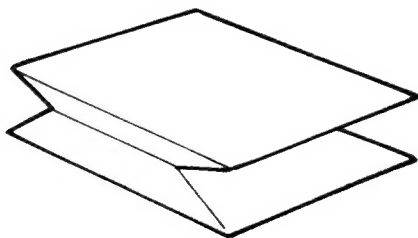① Fuse   1
② Fiber pen (aqueous)
   Black, red, blue, green, brown and orange   1 each
③ Soft cover   1
④ Instruction manual   1
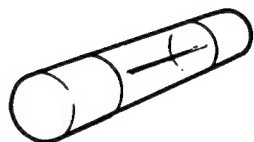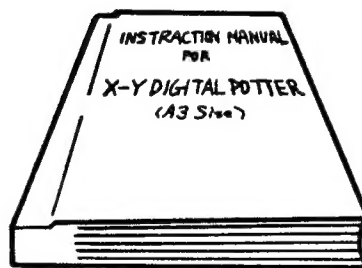
Fuse
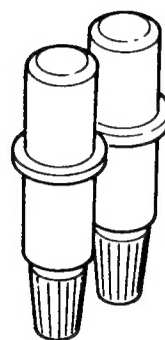
Pen

Soft cover

Instruction manual

3-3. Functions

Power switch

Push the "O" mark side to turn on the plotter.

Paper loading lever

Pull this lever to your side. The pinchwheel sinks and holds the paper. Plotting is made in this state.

Paper stopper

Use this stopper to position the paper when loading it. When the paper loading lever is pulled, this stopper sinks in the hole.

Pen carousel

Holds six pens at a time. It is detachable from the plotter body. Pull it out from the plotter when loading pens.

Control panel

Consists of control keys and indicators. Details of key operation will be described later.

Input/output connector

Provided with an GP-IB interface connector and a serial interface connector. Pin arrangement will be described later.

Dip switch

This is used at changing the paper size or the interface, for example. Details will be shown in the table provided below.

Fuse holder

Use a 1 A fuse when the supply voltage is 100/120 V AC. Use a 0.5 A fuse when the supply voltage is 220/240 V AC.

< How to use the Dip switch >

Each bit of the 10-bit Dip switch located on the rear panel of the plotter is used for the following purpose.

No.	Purpose	OFF	ON	State at shipment
1 ~ 3	Baud rate setting	Refer to the "Interface" section.		4800 baud
4	Stop bit	1	2	2
5	Parity	Odd	Even	Odd
6		No	Yes	No
7	Communication mode	Standard	Eaves-drop	Standard
8	Paper size	ISO standard (MET)	ANSI standard (US)	ANSI
9		A4 or A	A3 or B	A3/B
10	Interface	GP-IB	Serial	GP-IB

Setting at shipment is as shown below. Change it before operating the plotter. The switch lever is OFF in the horizontal state and ON when it is moved down.

– 5 –
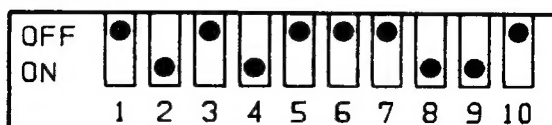
3-4. Control panel
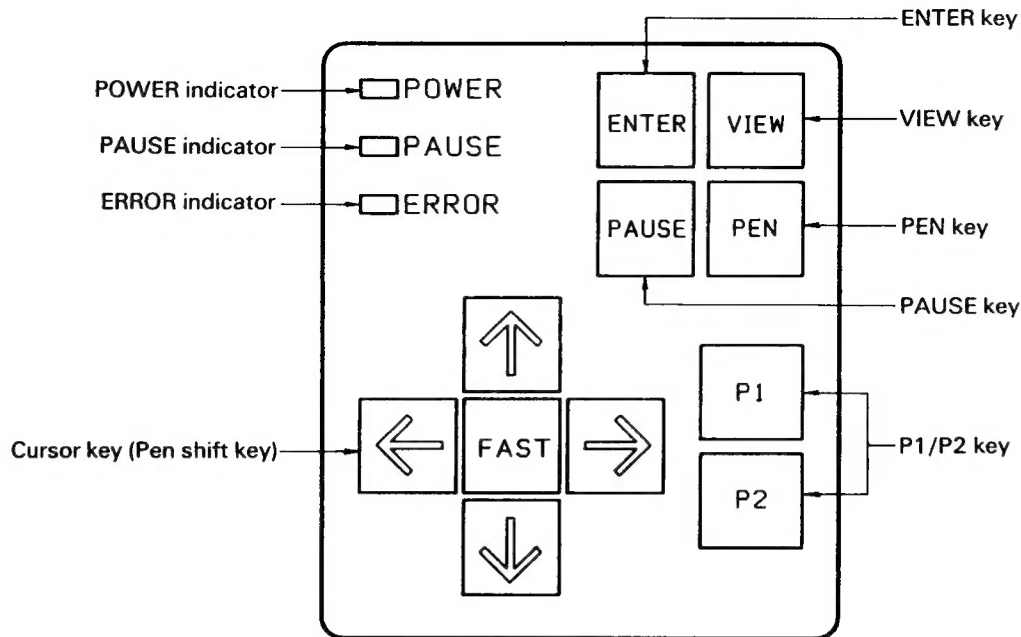
< Indicators >
POWER indicator (green)

Lights when the power switch is turned ON on the side of the plotter.

PAUSE indicator (orange)

Lights in the following cases:

(1) The paper loading lever is pushed to the opposite side to release the paper holding.
(2) The PAUSE key is pressed to pause the plotting operation.
(3) The VIEW key is pressed to pause the plotting operation.
(4) In the digitize mode, this indicator blinks to warn to specify the digitize point.
   When the cursor key (pen shift key) is operated to move the pen and the ENTER key is pressed, the indicator stops blinking, indicating that the valid digitize point is stored.

ERROR indicator (red)

Lights on at occurrence of error.

(It indicates detection of the I/O error with the error mark not set or the error related to SK-GL.)

< Control keys >
P1/P2 keys

When the P1 key (or P2 key) is pressed, the pen is raised and moved to the P1 (or P2) position being set.
When the ENTER key is pressed together with the P1 key (or P2 key), the pen position of that time is set at the new scaling point P1 (or P2).
For the details, refer to "Manual setting of scaling point" of Coordinate System.

VIEW key

When this key is pressed, the PAUSE indicator is lit. The plotter pauses the plotting operation. The pen is raised and the whole paper is fed forward so that the whole area of plotting is seen.
When this key is pressed again, the PAUSE indicator goes out and the pen returns to the coordinate position where the plotting operation is paused and then, the plotting operation is resumed.

PEN key

Pressing this key reverses the current pen state (up or down).
If the cursor key is operated together with this key, it is permitted to draw a line or digitize a point.

PAUSE key

When this key is pressed, the PAUSE indicator lights and the plotter pauses the plotting operation and raises the pen.

When this key is pressed again, the PAUSE indicator goes out and the plotting operation is resumed.

Cursor keys (Pen shift keys) and FAST key

These five keys are used to move the pen within the plotting area.

(1) When this key is pressed, the pen moves in the arrow direction marked on the key top.

(2) When two adjacent keys are pressed simultaneously, the pen moves in the 45° direction.

(3) When you wish to move the pen quickly, press the center FAST key, too. The pen moves at the speed of approx. four times.

ENTER key

This key does not work even if it is pressed. It works only when it is pressed together with another key. The functions of this key are as follows:

(1) ENTER key and P1/P2 key

Defines the current pen position as a new P1 (P2 in the case of P2 key) scaling point.

As for the order of setting the scaling point at this time, be sure to set P2 after setting P1.

(2) ENTER key and FAST key

Rotates the coordinate system 90°. For the details, refer to the "Rotation of coordinate system" of Plotter Instructions.

(3) ENTER key and PEN key

Returns the pen hold in the pen carriage to the pen carousel. Then, the pen carriage returns to the original state.

(4) ENTER key and VIEW key

Returns all functions to the initial set state.

This will be the same as when the power is once turned off and turned on again.

< Paper loading lever and PAUSE indicator >

(1) When the paper loading lever is pushed to the opposite side, the PAUSE indicator is lit and the following operations are executed.

● The pinchwheel rises and release paper holding.

● The pen held in the pen carriage is returned to the original position of the pen carousel.

● The pen carriage moves to the right end.

(2) When the paper loading lever is pulled to your side, the PAUSE indicator goes out and the following operations reexecuted.

● The pinchwheel lowers and holds the paper.

● The plotter recognizes that a new paper is loaded. However, P1 and P2 set before are unchanged from the original positions.

● If an error caused by the limitation of the paper size occurred before, it is cancelled here.

4. PREPARATION FOR PLOTTING

4-1. Installation of the Plotter

Set the plotter on the flat surface.

4-2. Loading the Paper

Glossy blank paper, coated paper and measurement paper can be used. The coated paper is recommended as it blots minimum.

< Loading procedure >

(1) Push the paper loading lever to the opposite side and insert the paper under the pinchwheel. Put the paper to the left side as far as possible and insert it in parallel along the wall.

(2) Insert the paper till it butts against the paper stopper.

(3) When the paper butts against the paper stopper, pull the paper loading lever to your side. The pinch wheel lowers and holds the paper.
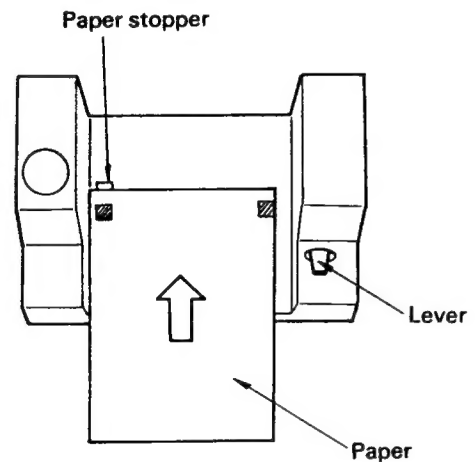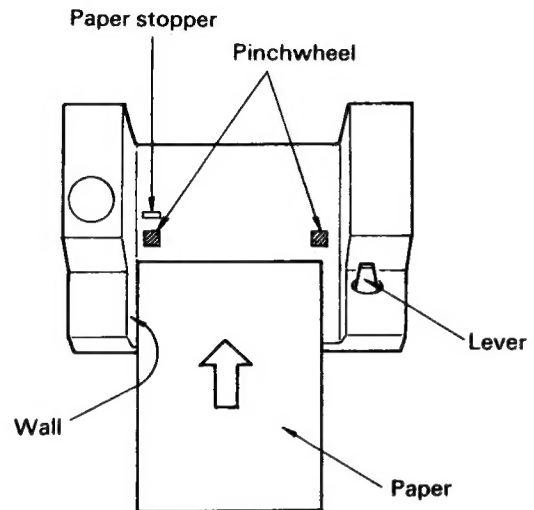
< Paper size and pinchwheel position >

The plotter permits to use both paper of ANSI and ISO standards. However, it is necessary to change the pinchwheel position of the plotter according to the paper size.

Set the pinchwheel at the appropriate position by making reference to the following illustrations.

(1) ANSI paper (A/B)
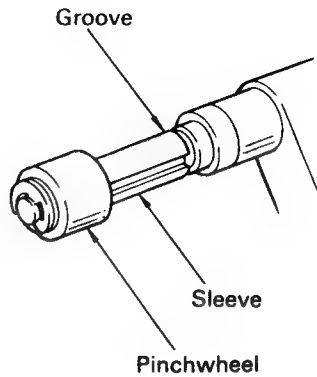
Paper size
    A: 216 × 279 (mm)   (8.5 × 11 in.)
    B: 279 × 432 (mm)   (11 × 17 in.)

Fit the pinchwheel securely in the sleeve groove.

(2) ISO paper (A4/A3)
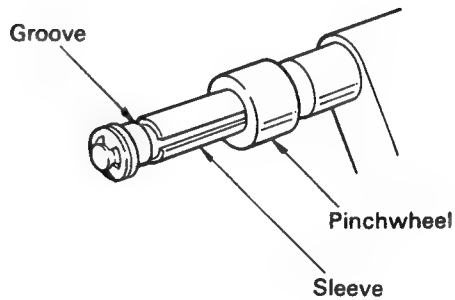
Paper size
    A4: 210 × 297 (mm)
    A3: 297 × 420 (mm)

Fit the pinchwheel securely in the sleeve groove.

4-3. Loading the Pen Carousel and Pens

The pen carousel contains six pens and automatically rotates in the plotter to provide pens alternately. The pen carousel is detachable from the plotter. Mount and demount the pen carousel from the plotter according to the following procedure.

< Mounting the pen carousel >
(1) Pinch the pen carousel top with your fingers and lower it vertically into the mount hole of the plotter.

(2) When the pen carousel makes contact with the convex of the hole bottom, rotate it slightly to the left or right.

(3) When the joint mark coincides during the rotating operation, the pen carousel sinks a little and then stop.
Now the pen carousel has been mounted.

< Demounting the pen carousel >
Pinch the pen carousel top with your fingers and lift it vertically and gently.

Note: The pen carousel is a highly sophisticated part. It may go out of order if it is exposed to a strong force or dropped on the floor. Be careful when handling it.

Pen carousel

Top

Pens

Mount hole

Plotter
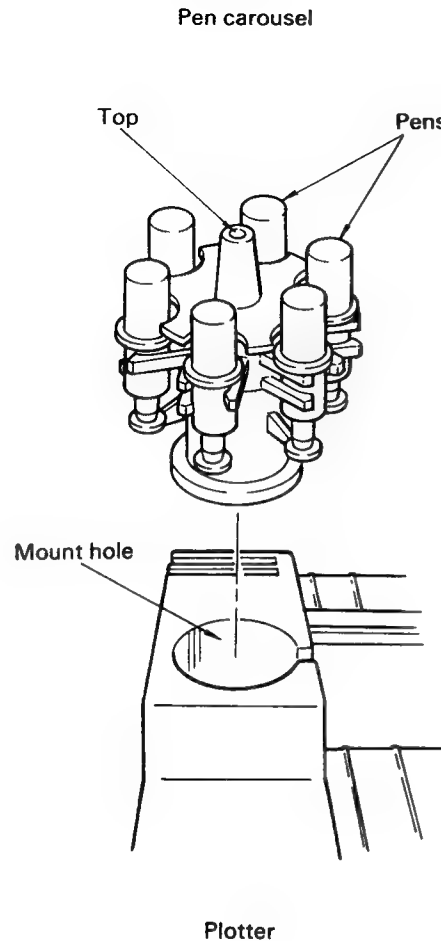
< Loading pens >

All of supplied six pens are used in being loaded in the pen carousel. Load the pens in the following proce-
dure.

(1) Remove the pen cap.

Pen cap
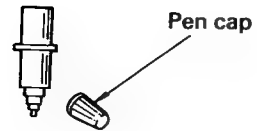
Pen carousel

(2) Push the capping mechanism of the pen carou-
     sel down.

Pen
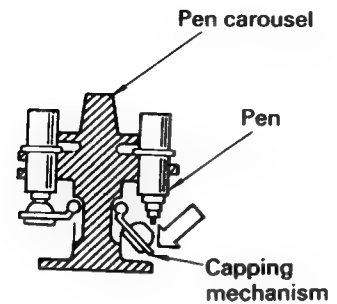
Capping
mechanism

(3) Push the pen so that pen flange is parallel to the
     pen holding pawl of the pen carousel.
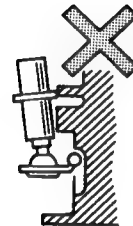
Example of wrong loading

(4) Release your hand from the capping mechanism
     and cap the pen point.
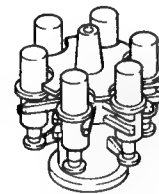
Completed view

4-4. Setting of Paper and Dip Switch

When the paper size is changed, it is also necessary to change setting of the Dip switch located on the rear panel of the plotter.

Setting of paper size and Dip switch is as follows.

Paper size		Dip switch setting	
		8th bit	9th bit
ANSI standard (US)	A	ON	OFF
	B	ON	ON
ISO standard (MET)	A4	OFF	OFF
	A3	OFF	ON

Before shipment, the Dip switch is set to the ANSI standard and B size.

```
OFF  ⊓⊓⊓⊓⊓⊓⊓  ⊓
ON   ⊔⊔⊔⊔⊔⊔⊔●●⊔
     1 2 3 4 5 6 7 8 9 10
```

4-5. Self-test

The plotter has the self-test function to check by itself.

With this function, draw the self-test pattern as shown later. If the test pattern is drawn to the end without any abnormality, the plotter is judged normal. (The interface functions are excluded.)

< Self-test procedure >

(1) Set six pens in the pen carousel.

At this time, do not set the pen in the pen carriage of the plotter. Pen color and No. are not particularly correlated.

(The pen No. is engraved on the pen holder top.)

(2) Mount the pen holder on the plotter.

(3) Load the paper.

The A3 size paper is optimum.

(Refer to the "Loading the paper".)

(4) Turn on the power switch while pressing the [←] key of the cursor key (pen shift key) on the control panel.

(5) The plotter draws the self-test pattern as shown below.

(6) After performing self-test, the plotter enters the normal input standby mode.

SPL-430 Self Test

BAR CHART
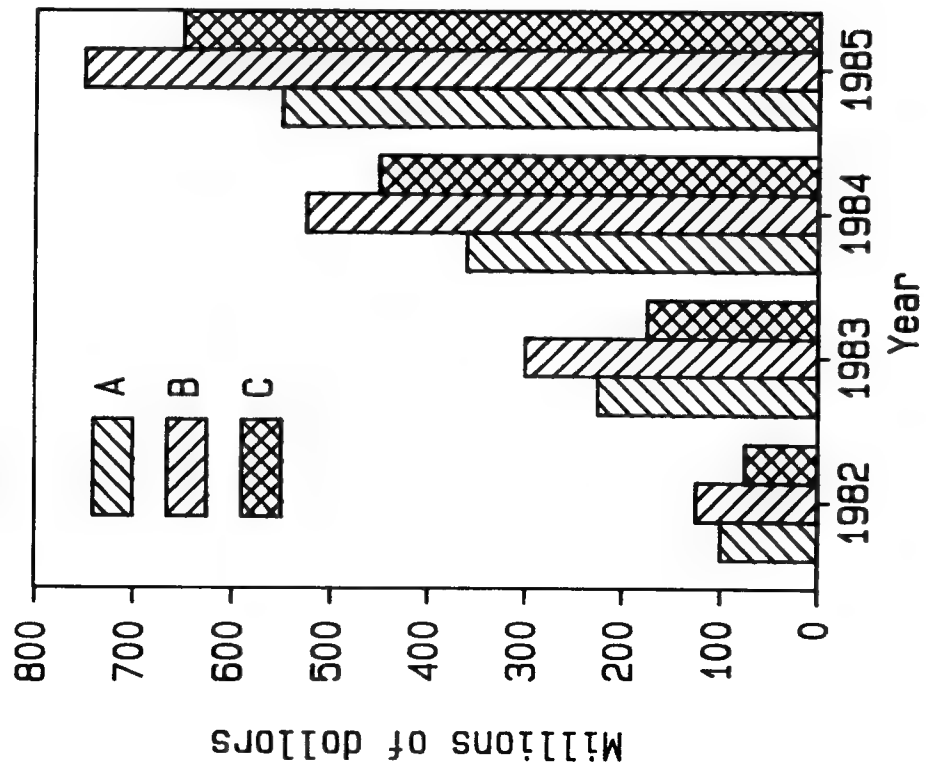
PIE CHART
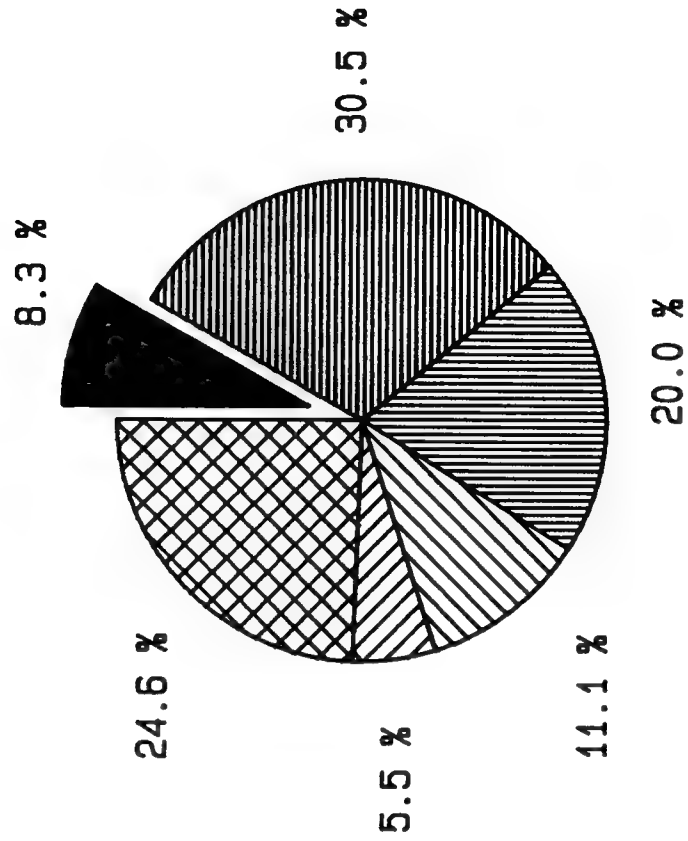
5. INTERFACE

5-1. Notes on Connection

(1) Connect the power cord to an AC outlet and cable to computer securely so that they do not become loose or disconnect during operation.

(2) To make the plotting operation by connection with a computer make sure that the plotter is normal beforehand by drawing the self-test pattern.

(3) Before connecting the input/output cable with a computer, read reference books on the computer interface and examine the description on the plotter interface provided below.

The plotter is provided with serial interface (conformable to RC232C) as standard and an optional 8-bit parallel (conformable to CENTRONICS) or BP-IB (conformable to IEEE-488) interface.

Select the interface according to the interface of the computer to be used.

For selection of interface , set the 10th bit of the DIP switch located on the rear panel of the plotter. Kinds of interface and correlation with the Dip switch are as shown below:

Kind of interface	Setting of Dip switch
	10th bit
8-bit parallel or GP-IB	OFF
Serial	ON

The GP-IB or 8-bit parallel mode is set before shipment.

```
OFF  ░░░░░░░░░░●
ON   ░░░░░░░░░░
     1 2 3 4 5 6 7 8 9 10
```
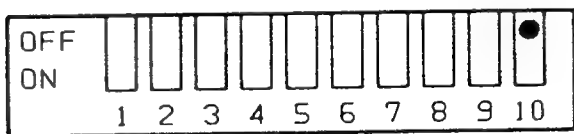
WARNING

Use the shielded cable for interface connection to avoid interference to radio communications.

5-3. GP-IB Interface (conforming to ANSI/IEEE std. 488-1978)

(1) Functions

Function	Subset	Description
Source Handshake	SH1	Capability of Source Handshake function.
Acceptor Handshake	AH1	Capability of Acceptor Handshake function.
Talker	T6	Capability of Basic Talker function. No capability of Talker Only function. Unaddress if MLA (My Listen Address).
Listener	L3	Capability of Basic Listener function. No capability of Listen Only function. Unaddress if MTA (My Talk Address).
Service Request	SR1	Complete capability of all Service Request functions.
Remote/Local	RL0	No capability of Remote/Local function.
Parallel Poll	PP2	Capability of PP2 function if (address) < 8. PP1 with other addresses, and PP0 if Listen Only.
Device Clear	DC1	Complete capability of all Device Clear functions.
Device Trigger	DT0	No capability of Device Trigger function.
Controller	C0	No capability of Controller function.

(2) Signal Levels

Input logic level

Logic "0": +2.0 ~ +5
Logic "1": 0 ~ +0.8V

Output logic level

Logic "0": +2.5 ~ +5V
Logic "1": 0 ~ +0.5V

(3) Input/Output connectors

- Connector on cable
  DDK 24-pin (57-10240) equivalent
- Connector pin configuration

- Connector on plotter
  DDK 24-pin (57-20240) equivalent

Pin	Signal Name	Pin	Signal Name
1	DIO 1	13	DIO 5
2	DIO 2	14	DIO 6
3	DIO 3	15	DIO 7
4	DIO 4	16	DIO 8
5	EOI	17	REN
6	DAV	18	GND (6)
7	NRFD	19	GND (7)
8	NDAC	20	GND (8)
9	IFC	21	GND (9)
10	SRQ	22	GND (10)
11	ATN	23	GND (11)
12	Shielded	24	Logic GND

Nut M3.5 × 0.6
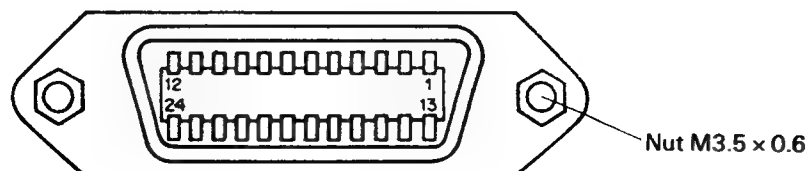
(4) Address Switch Setting

Plotter addresses can be set using the five-pole switch on the rear of the plotter. When all of the five switches are set to "OFF", the plotter enters the Listen Only mode, receiving all data transferred on the buses. As the plotter cannot be used as a tolker in this mode, no response is given to serial poll and parallel poll.

The address code has been factory preset to "05", which corresponds to listen character "%" and talk character "E".

The list of address settings is as shown below.

Address Settings

Address Code	Address Character		Address Switches				
	Listen	Talk	1	2	3	4	5
0	SP	@	ON	ON	ON	ON	ON
1	!	A	OFF	ON	ON	ON	ON
2	"	B	ON	OFF	ON	ON	ON
3	#	C	OFF	OFF	ON	ON	ON
4	$	D	ON	ON	OFF	ON	ON
5	%	E	OFF	ON	OFF	ON	ON
6	&	F	ON	OFF	OFF	ON	ON
7	'	G	OFF	OFF	OFF	ON	ON
8	(	H	ON	ON	ON	OFF	ON
9	)	I	OFF	ON	ON	OFF	ON
10	*	J	ON	OFF	ON	OFF	ON
11	+	K	OFF	OFF	ON	OFF	ON
12	,	L	ON	ON	OFF	OFF	ON
13	−	M	OFF	ON	OFF	OFF	ON
14	.	N	ON	OFF	OFF	OFF	ON
15	/	O	OFF	OFF	OFF	OFF	ON
16	0	P	ON	ON	ON	ON	OFF
17	1	Q	OFF	ON	ON	ON	OFF
18	2	R	ON	OFF	ON	ON	OFF
19	3	S	OFF	OFF	ON	ON	OFF
20	4	T	ON	ON	OFF	ON	OFF
21	5	U	OFF	ON	OFF	ON	OFF
22	6	V	ON	OFF	OFF	ON	OFF
23	7	W	OFF	OFF	OFF	ON	OFF
24	8	X	ON	ON	ON	OFF	OFF
25	9	Y	OFF	ON	ON	OFF	OFF
26	:	Z	ON	OFF	ON	OFF	OFF
27	;	[	OFF	OFF	ON	OFF	OFF
28	<	\	ON	ON	OFF	OFF	OFF
29	=	]	OFF	ON	OFF	OFF	OFF
30	>	<	ON	OFF	OFF	OFF	OFF
31	?	−	OFF	OFF	OFF	OFF	OFF

(*1) Factory setting   (*2) Listen Only mode

(*1) marks Address Code 5. (*2) marks Address Code 31.

```
OFF  ●   ●
ON     ●   ● ●
     1 2 3 4 5
```
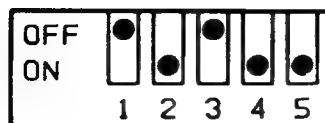
(5) Relationship between Parallel Poll and Plotter Address

The following table shows the relationship between GP-IB data lines which are set during parallel polling and plotter addresses. The PP2 function is available with plotter addresses from 0 to 7.

Plotter Address	Parallel Poll Bit Position	No. of GP-IB Data Line	
0	7	8	
1	6	7	
2	5	6	
3	4	5	
4	3	4	
5	2	3	Factory setting
6	1	2	
7	0	1	

PP1 functions are available with other plotter addresses.

5-4. Serial Interface (Conformable to RS-232-C)

(1) Synchronizing system
   Start-stop system
(2) Communication speed (Baud rate)
   150, 300, 600, 1200, 2400, 4800, 9600 or external clock
(3) Communication format
   Start bit: 1 bit
   Data: 8 bits (or 7 bits with parity)
   Parity: Even, odd or no parity
   Stop bit: 1 or 2 bits
(4) Buffer memory size
   1024 bytes
(5) Input/output circuit configuration and input/output characteristics
   ● RXD, CTS, DSR, Second RXD and External clock

75189
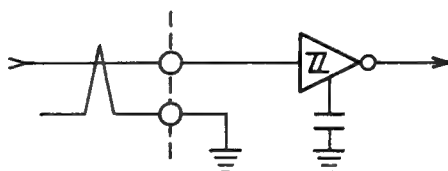
ON (SPACE): +5 ~ +12 V (typ.) .... "0"
OFF (MARK): −5 ~ −12 V (typ.) .... "1"

   ● TXD, RTS, DTR, Second TXD

+12V   75188
−12V
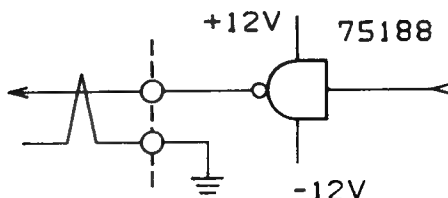
ON (SPACE): +5 ~ +8 V (typ.) .... "0"
OFF (MARK): −5 ~ −8 V (typ.) .... "1"

(6) Input/output connectors
   ● Connector of cable
     EIA standard 25-pin plug type (JAE DB-25P or equivalent)
   ● Connector of plotter
     EIA standard 25-pin socket type (JAE DB-25S or equivalent)

● Pin arrangement of connector

Pin	Signal	Name of signal	Direction	Function
1	FG	Protective ground	—	Frame ground
2	TXD	Transmitted data	Output	Transmit the serial transmission data and X parameter.
3	RXD	Received data	Input	Serial receiving data
4	RTS	Request to send	Output	Usually ON (+ potential)
5	CTS	Clear to send	Input	Permit transmission for the plotter.
6	DSR	Data set ready	Input	————
7	SG	Signal ground	—	————
14 (*1)	Second TXD	Secondary transmitted data	Output	Transmission data from the plotter to the terminal
16 (*1)	Second RXD	Secondary received data	Input	Receiving data from the terminal
17 (*2)	External clock	External clock input	Input	Reference clock signal for transmission/reception using an external clock (*3)
20	DTR	Data terminal ready	Output	DTR control signal
23	DSRS	Data signal rate selector	Output	Usually ON (+ potential)

*1. Used in the Eaves-drop mode
(The Eaves-drop mode will be explained later.)

*2 This signal determines the data transmission/reception speed when all of first, second and third bits of the Dip switch located on the rear panel of the plotter are OFF. For the clock frequency, input the value of 16 times larger than the baud rate to be used.
This frequency is limited to 310 kHz maximum.

*3 When an external clock is used, it must be supplied before the plotter power switch is turned on.

(7) Handshake mode

The handshake mode is available in DTR control mode and X parameter control mode. These two modes are selectable at the software level.

When the power switch is turned on, the DTR control mode is automatically set.

DTR signal	X parameter	Function
ON	X on send (DC1)	Much capacity of buffer memory is left.
OFF	X off send (DC3)	Less capacity of buffer memory is left.

Note: The X parameter code is selectable by RS-232-C control command.

(8) Setting of communication format

● Set the communication format in the first to seventh bits of the Dip switch located on the rear panel of the plotter. Setting of the Dip switch is as shown below.

Bit No.	Function	Setting of switch	
		OFF	ON
1, 2, 3	Baud rate	Details are shown in another table.	
4	Stop bit	1	2
5	Parity	ODD	EVEN
6		NO	YES
7	Communication mode	Standard mode	Eaves-drop mode

The baud rate setting is as shown below.

Baud rate	1st bit	2nd bit	3rd bit
150	ON	ON	ON
300	OFF	ON	ON
600	ON	OFF	ON
1200	OFF	OFF	ON
2400	ON	ON	OFF
4800	OFF	ON	OFF
9600	ON	OFF	OFF
External clock	OFF	OFF	OFF

● The format setting is as follows before shipment.

Baud rate: 4800
Stop bit: 2
Parity: No
Communication mode: Standard mode

The interface selector switch is set to the GP-IB mode.
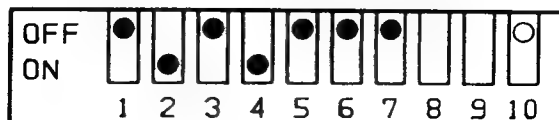
5-5. 8-bit Parallel Interface (Conformable to CENTRONICS)
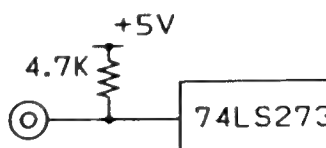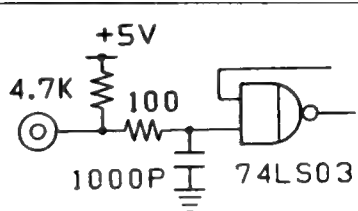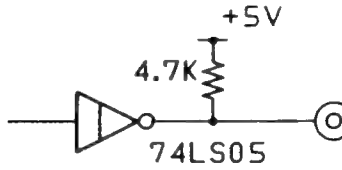
(1) Control signals

$\overline{STB}$ BUSY $\overline{ACK}$ $\overline{ERROR}$

(2) Input data:
    . 7 bits or 8 bits

(3) Input circuit configuration and input/output conditions

	Name of signal	Circuit configuration	
. Input	DATA 1 ~ 8	+5V 4.7K 74LS273	Logical input level "1" = 2.0 ~ 5V "0" = 0 ~ 0.8V
Input	$\overline{STB}$	+5V 4.7K 100 1000P 74LS03	
Output	BUSY $\overline{ACK}$ $\overline{ERROR}$	+5V 4.7K 74LS05	Logical output level "1" = 2.4 ~ 5V "0" = 0 ~ 0.4V

(4) Timing chart

- 20 -
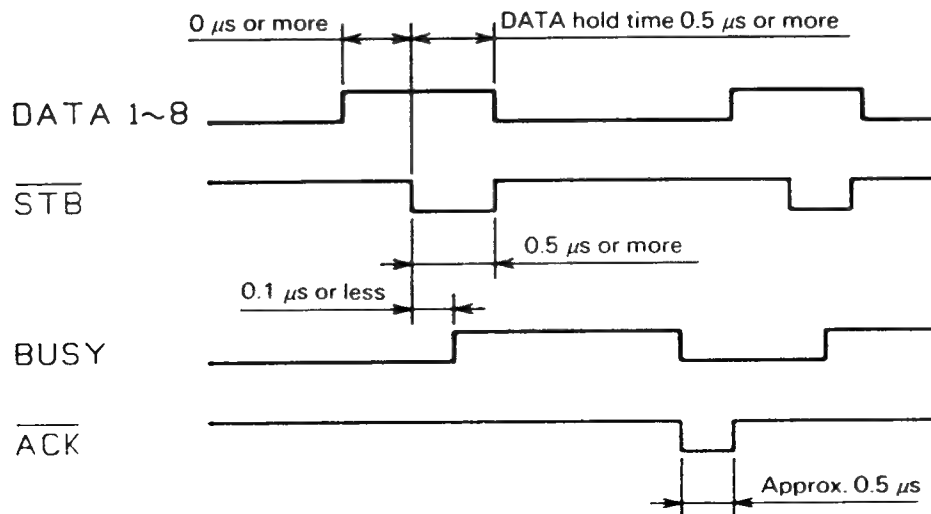
(5) Input connectors
- Connector of cable
  36-pin (DDK 57-30360 or equivalent)
- Connector of plotter
  36-pin (DDK 57-40360 or equivalent)
- Pin arrangement of connector

Pin	Signal	Direction	Function
1	$\overline{STB}$	Input	Strobe pulse. The pulse width needs to be 0.5 μs. The signal level is normally "HIGH"; read-in of data is performed at the negative going edge of this signal.
2	DATA1	Input	8-bit data signal. HIGH level at logical "1" and LOW at "0".
3	DATA2	Input	
4	DATA3	Input	
5	DATA4	Input	
6	DATA5	Input	
7	DATA6	Input	
8	DATA7	Input	
9	DATA8	Input	
10	$\overline{ACK}$	Output	Acknowledge output. The pulse width is about 0.5 μs. It indicates completion of data reception.
11	BUSY	Output	When this signal is HIGH, it indicates that the plotter is in the state disabling data reception. Conditions for change for BUSY to HIGH are: (1) Data input period (2) During the plotting operation
12	GND	—	
13	—	—	PULL UP to 5V
14	—	—	
15	—	—	
16	GND		
17	F.G.		
18	5V	—	Inhibited to use
19 ∫ 30	GND	—	GND for returning ≠ 1 ~ ≠ 11
31	—	—	
32	$\overline{ERROR}$	Output	When this signal is LOW level, it indicates that the plotter is in the error state.
33	GND	—	
34	—	—	
35	—	—	
36	—	—	

5-6. Others

(1) EAVES-DROP mode

This mode is selected by the Dip switch located on the rear panel of the plotter. Turn on the No.7 switch of the Dip switch to set this mode.

This mode is effective to control the plotter and terminal with one serial line from the computer.

In the standard mode, data is transferred between the plotter and computer. In the EAVES-DROP mode, data is transferred between the computer and terminal. At this time, the Y cable connector is used.

The conception of the EAVES-DROP mode is diagrammatically shown below.
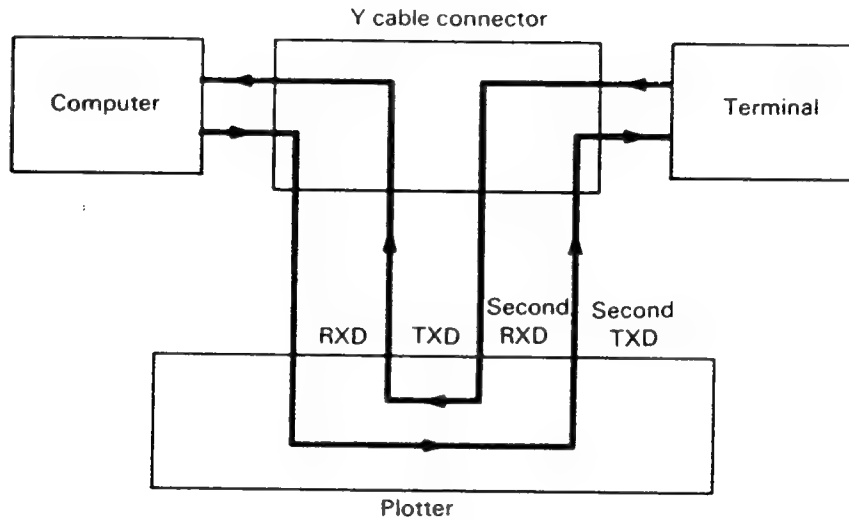
6. COORDINATE SYSTEM OF PLOTTER

6-1. Coodinate System

The area in which the pen moves and draw graphics on the paper is called a plotting area of the plotter. This area is a two-dimensional rectangular coordinates, which is divided into fine grids. Each crossing point of grids is expressed as a coordinates of X and Y taking the coordinate origin (X = 0, Y = 0) as a reference. Namely, the plotter draws graphics by moving the pen following the coordinate points (X,Y) determined based on the numeric values specified as parameters of plotting command.

< The plotter unit and user unit >
The coordinate system is available in the "plotter unit" where the grid interval (resolution) is fixed, and the "user unit" where it is variable by the software. The numeric value range given as parameters of the plotting command and understood by the plotter is -32767 ~ 32767 in both coordinates. The minimum unit (resolution) of position specification is 0.025 mm (25 microns) in both coordinates.

● The plotter unit
   The grid interval within the plotting area is set to 0.025 mm (25 microns). When a decimal is specified as a parameter of the plotting command, it is handled as an integer by discarding fractions.
● User units
   This coordinate system is set by the "SC" instruction utilizing the scaling point P1/P2. The grid interval is then not necessarily same in X and Y direction. Namely, plotting is possible by setting each direction as different standards. This coordinate system permits to use a decimal number having a decimal of 4 digits maximum as a parameter of the plotting instruction.

6-2. Direction of Coordinate System

Position of the coordinate origin (0,0) and direction of the X/Y axis of the plotter coordinates are different according to the paper size as shown below. These direction are automatically set when the paper size is determined by the Dip switch on the rear panel of the plotter.

< Coordinate system and initial setting of scaling point P1/P2 for different paper size >

Paper size A, A4
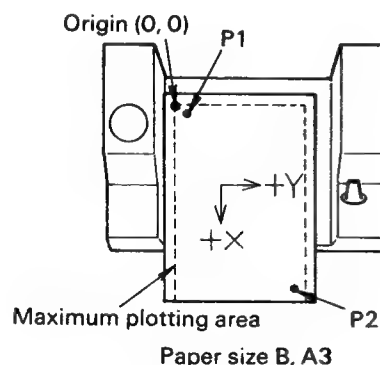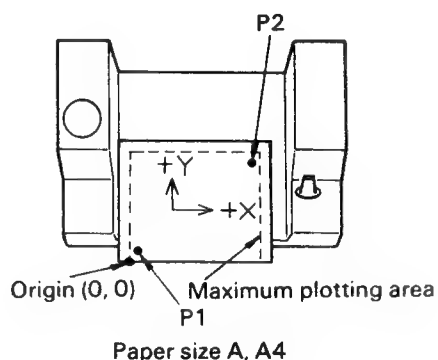
Paper size B, A3

6-3. Effective Plotting Area (Window)

The area in which the pen is movable on the paper is called an effective plotting area.

The maximum effective plotting area (plot limit) is limited according to paper size as shown in the following table and automatically set when the paper size is selected by the Dip switch on the rear panel of the plotter.

The effective plotting area is variable by the "IW" instruction at the software level within the maximum effective plotting area. When the power switch is turned on, the effective plotting area (window) is set to the same as the maximum effective plotting area (plot limit).

Paper size	Dip switch		Maximum effective plotting area (Plot limit)	
	8-bit	9-bit	X axis	Y axis
ANSI A (216 × 279 mm)	ON	OFF	0 ~ 10365 (259.1 mm)	0 ~ 7962 (199.1 mm)
ANSI B (279 × 432 mm)	ON	ON	0 ~ 16640 (416 mm)	0 ~ 10365 (259.1 mm)
ISO A4 (210 × 297 mm)	OFF	OFF	0 ~ 11040 (276 mm)	0 ~ 7721 (193 mm)
ISO A3 (297 × 420 mm)	OFF	ON	0 ~ 16158 (403.9 mm)	0 ~ 11040 (276 mm)

6-4. Scaling Point P1/P2

Two points (P1 and P2) called scaling points are provided to facilitate use of the user units.

These points are located in the oppositing diagonal direction.

Note that initial setting positions of these points (P1 and P2) are different as follows according to the paper size.

When the paper size is A or A4, P1 is at the left below corner and P2 is at the right above corner.

When the paper size is B or A3, P1 is at the left above corner and P2 is at the right below corner.

Initial setting values of these scaling points are shown in the following table. (The values are the coordinate values of the plotter unit system.)

Paper size	Initial value of scaling point	
	P1x, P1y	P2x, P2y
A	250, 596	10250, 7796
A4	603, 521	10603, 7721
B	522, 259	15277, 10259
A3	170, 602	15370, 10602

Positions of scaling point P1 and P2 are variable by the "IP" instruction at the software level.

They are also variable by the key operation on the front panel. To restore the P1/P2 position set once to the initial setting position, do any one of the following method.

● Turn on the power switch again.

● Execute "IN" or "IP" instruction without parameters.

● Key operation on the front panel.
   (Press ENTER and VIEW keys simultaneously.)

6-5. Manual Setting of Scaling Point

To set the scaling point P1/P2 by the key operation on the front panel, do it in the following procedure. As P2 is also moved when P1 is moved at this time, be sure to set P1 first and then, set P2.

< P1/P2 setting procedure >
(1) Operate the cursor key (pen shift key) to move the pen to the new P1 position.
(2) Press ENTER and P1 keys simultaneously to set the new P1 position.
(3) Operate the cursor key (pen shift key) to move the pen to the new P2 position.
(4) Press ENTER and P2 keys simultaneously to set the new P2 position.
(5) To make sure that the scaling points are correctly set, press P1 and P2 keys alternately to confirm that the pen moves to the desired position.

6-6. Rotating the Coordinate System

The coordinate system can be rorated 90° in either case of plotter units or user units. It should be noted however that the rotating direction is different according to the paper size. This function can be executed by the "RO" instruction at the software level. It is also executed by pressing ENTER and FAST keys on the front panel. In either method, the rotation angle is not accumulated and the direction of the coordinate system is changed alternately.

It is noted that P1/P2 scaling point and the physical size of the plotting area are different in the software method and the manual method by the key operation. The difference is diagrammatically shown below.

< 90° rotation by front panel operation >

A/A4

UR
P2 ●
+Y
+X
● P1
LL(0,0) Default

←→

LL(0,0)
● P1
+Y
+X
P2 ●
UR
90° rotation

Plot limit and window

B/A3

LL(0,0)
● P1
+Y
+X
P2 ●
UR
Default

←→

UR
P2 ●
+Y
+X
● P1
LL(0,0) 90° rotation

Plot limit and window
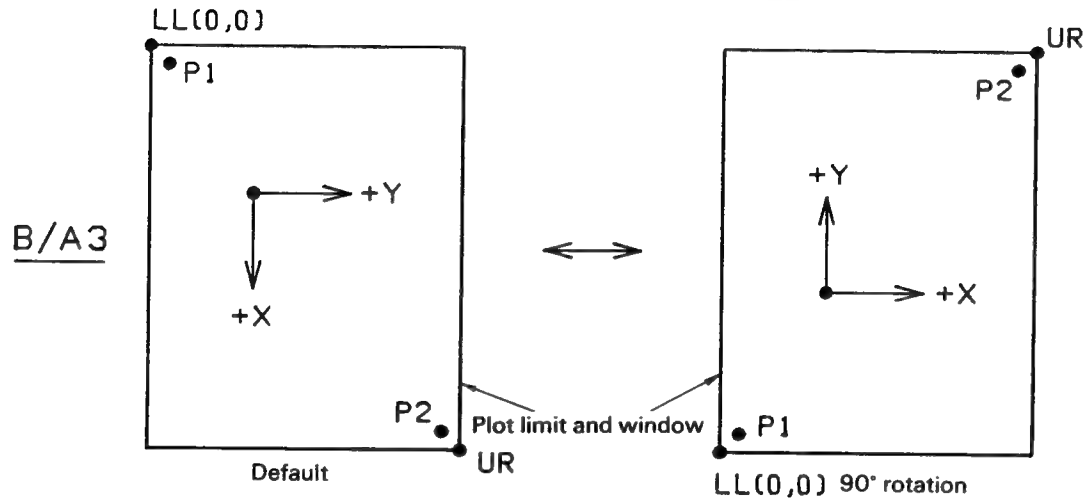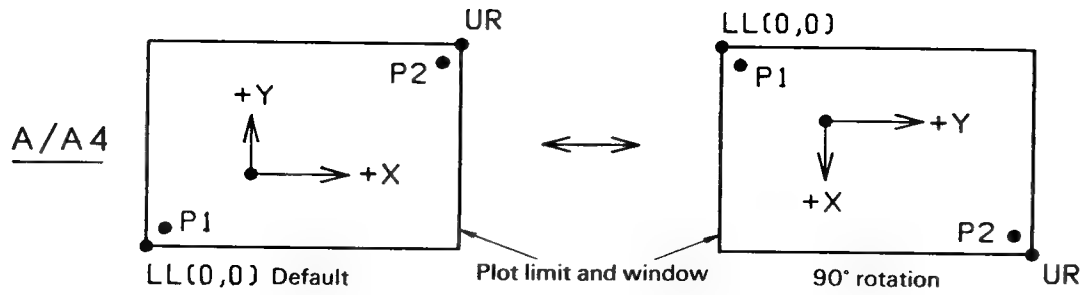
< 90° rotation by RO instruction >

A/A4

P2 ●
+Y
+X
UR
● P1
LL(0,0) Default

Plot limit and window

←→

LL(0,0)
● P1
Window
+Y
+X
Plot limit
UR
P2
90° rotation

B/A3

LL(0,0)
● P1
+Y
+X
P2 ■
UR
Default

Plot limit and window

←→

UR
Window
+Y
P2 ●
+X
● P1
LL(0,0) 90° rotation

Plot limit
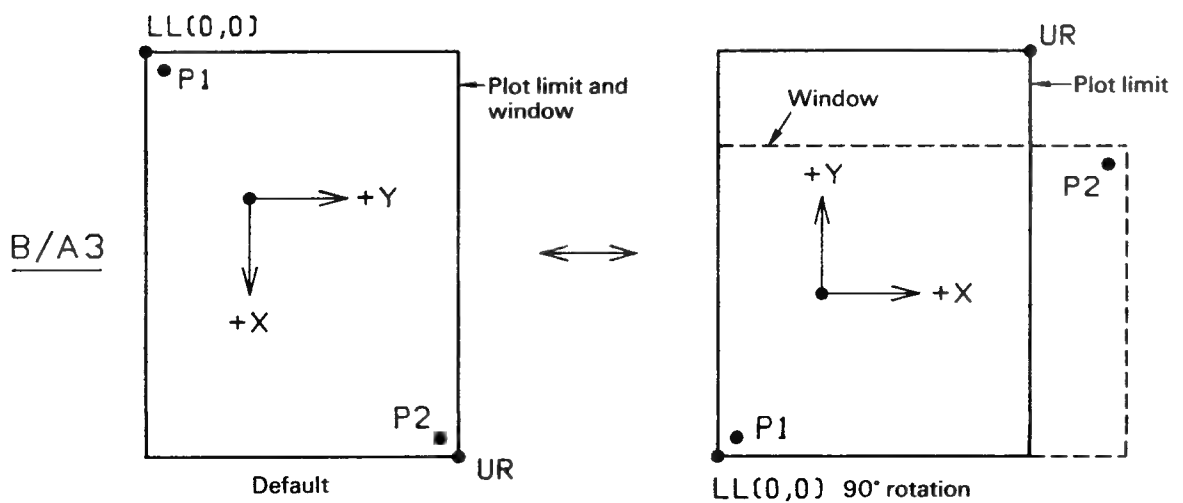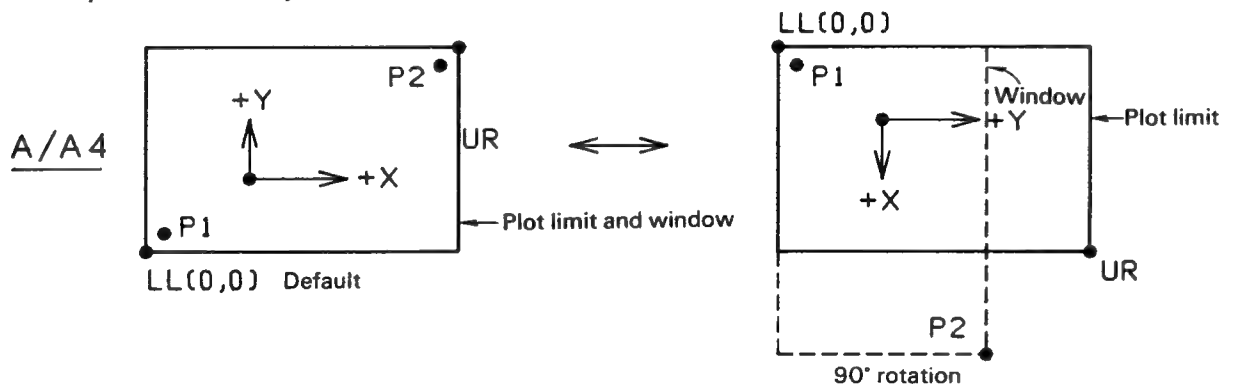
7. PLOTTER INSTRUCTIONS

7-1. SK-GL syntax

The SK-GL instruction is expressed by two alphabetic characters and composed of parameter field and terminator.

When a parameter is added, each parameter must be delimited by a separator (comma, space, sign, etc.).

Every command is directly executed after a mnemonic or executable final parameter is received, and is terminated by a semicolon (;) or the next mnemonic. However, when the parameters over the specified number are received, the required number of parameters are executed and an error 2 (parameter number error) is set.

Note: The syntax is shown below.

In SM and DT instructions, the first character of the mnemonic is interpreted as a symbol or a label terminator.

```
       Mnemonic                              Separator
   ┌───────┴───────┐                      ┌──────┴──────┐
[Sep]  [X]  [Sep]  [X]  [Sep] [Parameter] [Sep] [Parameter] [Sep] [Terminator]
   └──────┬─────────────┘
       Arbitrary separator
```
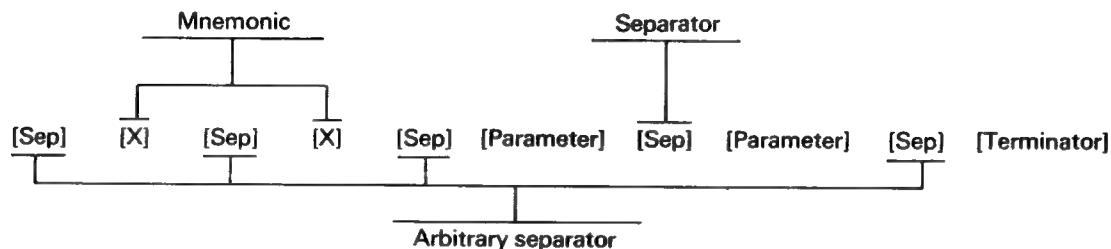
When the parameter is omitted, all parameters must be omitted except in the cases of FT and UC instructions. When the parameter is omitted, the initial value is set. The LB instruction is exceptionally out of the above format. It must be terminated by a label terminator character. This character is initially set in "end of text", ETX (3 in the decimal ASCII), but changeable by the DT instruction.

The parameter must satisfy one of the following formats.

1. $-32,767 \leqq n \leqq +32,767$ (Integer format)

   Integer parameter. The decimal part is discarded. When there is no sign, it is regarded as a positive integer.

2. $-128.0000 \leqq n \leqq +127.9999$ (Decimal format)

   A real number comprising a decimal point and 4-digit decimal number. It is regarded as a positive number when there is no sign.

3. $-32,767.0000 \leqq n \leqq +32,767.9999$ (Scaled decimal format)

   A real number comprising a decimal point and 4-digit decimal number. It is regarded as a positive number when there is no sign.

4. Character string (Label fields)

   A combination of text, numeric expressions and character strings.

Note: The scaled decimal format can be used when the scaling mode is ON, and applied to all parameters judged as a user unit.

The following signs are used in the explanation of SK-GL instruction.

MN emonic	....	Indicated by capital letters and discriminated from the parameter and terminator.
(　)	....	Indicates a desired parameter.
c . . . c	....	Indicates a character string.
(, . .)	....	Indicates a pair of X and Y positions.
Terminator	....	Terminator must be included in instructions having a semicolon (;) or next mnemonic parameter.

7-2. Plotter Instruction Set

INSTRUCTION		DESCRIPTION	Page
AA	X[i/sd], Y[i/sd], arc angle [i] (,chord angle [i])	Arc absolute	36
AR	X[i/sd], Y[i/sd], arc angle [i] (,chord angle[i])	Arc relative.	36
CA	n[i]	Designate alternate set n.	42
CI	radiys[i/sd] (,chord angle[i])	Circle.	35
CP	spaces[d], lines[d]	Character plot.	46
CS	n[i]	Designate standard set n.	42
DC		Degitize clear.	48
DF		Set default values.	28
DI	run[d], rise[d]	Absolute direction.	45
DP		Degitize point.	47
DR	run[d], rise[d]	Relative direction.	45
DT	c[c]	Difine label terminator.	43
EA	X[i/sd], Y[i/sd]	Edge rectangle absolute.	38
ER	X[i/sd], Y[i/sd]	Edge rectangle relative.	39
EW	radius[i/sd], start angle[i], sweep angle[i] (,chord angle[i])	Edge Wedge.	40
FT	type[i] (,spacing[sd] (; angle[i]))	Fill type.	37
IM	e[i]	Input error mask.	29
IN		Initialize.	29
IP	P_{1x}[i], P_{1y}[i], (,P_{2x}[i], P_{2y}[i])	Input P1 and P2.	30
IW	X_{lo}[i], Y_{lo}[i], (,X_{hi}[i], Y_{hi}[i])	Input window.	31
LB	c . . . c[c]	Label ASCII string.	44
LT	t[d] (,l[d])	Designate line type and length.	41
OA	[i return]	Output actual position and pen status.	48
OC	[i/sd return]	Output commanded position and pen status.	48
OD	[i return]	Output Degitize point and pen status.	48
OE	[i return]	Output error.	49
OF	[i return]	Output factors.	49
OH	[i return]	Output hard-clip limits.	32
OI	[i return]	Output identification.	49

INSTRUCTION		DESCRIPTION	Page
OO	[i return]	Output options.	49
OP	[i return]	Output P1 and P2.	30
OS	[i return]	Output status.	50
OW	[i return]	Output window.	31
PA	X[i/sd], Y[i/sd] (, . . .)	Plot absolute.	34
PD	(X[i/sd], Y[i/sd] (, . . .))	Pen down.	33
PR	X[i/sd], Y[i/sd] (, . . .)	Plot relative.	35
PS	paper size[i]	Paper size.	30
PT	thickness[d]	Pen thickness.	37
PU	(X[i/sd], Y[i/sd] (, . . .))	Pen up.	33
RA	X[i/sd], Y[i/sd]	Shade rectangle absolute.	38
RO	n[i]	Rotate coordinate system.	32
RR	X[i/sd], Y[i/sd]	Shade rectangle relative.	38
SA		Select alternate character set.	43
SC	X_{min}[i], X_{max}[i], Y_{min}[i], Y_{max}[i]	Scale	31
SI	width[d], height[d]	Absolute character size.	46
SL	$\tan\phi$[d]	Absolute character slant (from vertical).	46
SM	c[c]	Symbol mode.	41
SP	n[i]	Select pen.	33
SR	width[d], height[d]	Relative character size.	46
SS		Select standard character set.	42
TL	t_0[d] (,t_n[d])	Tick length.	40
UC	(pen[i],) X[d], Y[d], pen[i] (, . . .)	User defined character.	47
VS	v[d]	Select velocity v.	33
WG	radius[i/sd], start angle[i], sweep angle[i] (,chord angle[i])	Shade wedge.	39
XT		X-axis tick.	40
YT		Y-axis tick.	40

[c]   = Character format.
[d]   = Decimal format, $-128.0000 \sim +127.9999$
[i]   = Integer format, $-32{,}767 \sim +32{,}767$
[sd] = Scaled decimal format, $-32{,}767.0000 \sim +32{,}767.9999$

7-3. SK-GL Instructions

DF	The Default Instruction

Format: DF terminator
Description: The DF instruction initializes the following plotter function.

Function	Equivalent instructions	Conditions
Plotting mode	PA;	Plotting in the absolute coordinate system
Relative character direction	DR1, 0;	Horinzontal direction
Line type	LT;	Solid line
Line pattern length	LT;	4% of (P1 – P2)
Input window	IW;	Maximum plotting area
Relative character size	SR;	Width = 0.42% of (P2x – P1x) Height = 1.12% of (P2y – P1y)
Symbol mode	SM;	OFF
Tick length	TL;	X-axis scale = 0.5% of (P2y – P1y) Y-axis scale = 0.5% of (P2x – P1x)
Standard character set	CS0;	Character set 0
Alternate character set	CA0;	Character set 0
Character set selected	SS;	Select the standard character set.
Character slant	SL0;	0°
Mask value	IM223, 0, 0;	Detect all errors.
Scale	SC;	OFF
Digitize clear	DC;	OFF
Pen velocity	VS;	40 cm/s (15.7 in/s)
Label terminator	DT ETX	ETX (3 in decimal ASCII)
Chord angle	—	5°
Fill type	FT;	Type 1 (bidirectional solid fill)
Fill spacing	FT;	1% of (P1 – P2)
Fill angle	FT;	0°
Pen thickness	PT;	0.3 mm

Note: No influence upon the following plotter functions.

● Positions of P1 and P2 scaling points.
● Pen state and position.
● 90° rotation of coordinate system.
● RS-232-C handshaking method.

IN	The Initialize Instruction

Format: IN terminator

Description: The IN instruction executes the following functions as well as setting equivalent to execution of the DF instruction.
- ● Pen up
- ● Clear all errors.
  Set the 3rd bit of the output status byte to indicate that the plotter is initialized.
- ● Set rotation of coordinate system to 0°.
- ● Set the coordinates of P1 and P2 scaling points as shown below.

Paper size	P1	P2
A	250 , 596	10250 , 7796
A4	603 , 521	10603 , 7721
B	522 , 259	15722 , 10259
A3	170 , 602	15370 , 10602

IM	The Input Mask Instruction

Format: IM E-mask value (, S-mask value (, P-mask value)) terminator or IM terminator

Description: The IM instruction sets the error occurring conditin with the E-mask value, GP-IB Service Request message occurring condition with the S-mask value, and GP-IB parallel poll response condition with the P-mask value. When the RS-232-C interface is used, the S-mask and P-mask values are not required, and are ignored even when they have been set. The E-mask value is used with both interfaces. The E-mask value is the sum of the combination of bit values as shown below.

Bit value	Bit	Error No.	Content
1	0	1	Undefined instruction
2	1	2	Abnormal number of parameters
4	2	3	Abnormal parameter
8	3	4	Not used
16	4	5	Undefined character set
32	5	6	Position overflow
64	6	7	Not used
128	7	8	Vector or «PD» received when the pinch wheel is up

When an error occurs, the bit in the mask corresponding to the error No. is tested in order to determine if it is necessary to set error bit (b5) of the status byte. If it is set, the ERROR LED on the front panel lights. In consequence, there is no means to determine if an error occurs when the corresponding bit has not been set.

The S-mask value is the sum of the bit values as shown below.

Bit Value	Bit	Content
1	0	Pen down
2	1	P1 or P2 modified
4	2	Digitized point effective
8	3	Initialized
16	4	Data reception possible (with pinch wheel down)
32	5	Error

For example, with S-mask value "4" the Service Request message is sent when the digitized point is effective (when bit 2 is set).

The P-mask value is also the sum of the bit values as shown below. It is used to indicate the state of the status byte which gives response in Logic 1 to the parallel poll of the GP-IB.

Bit Value	Bit	Content
1	0	Pen down
2	1	P1 or P2 modified
4	2	Digitized point effective
8	3	Initialized
16	4	Data reception possible (with pinch wheel down)
32	5	Error

The initial values of the parameters are set as follows:

IM223, 0, 0;

PS	The Paper Size Instruction

Format: PS paper size terminator

Description: The PS instruction changes the paper size, A and B or A4 and A3.

A new paper size is determined by the parameter and the paper size switch provided on the rear panel.

● 0 ～ 3: Set to B or A3.

● 4 ～ 127: Set to A or A4.

The parameters out of the range results in the error 3 and the instruction is ignored.

● It is impossible to change from US size to MET size by the PS instruction.

IP	The Input P1 and P2 Instruction

Format: IP P1x, P1y (, P2x, P2y) terminator or IP terminator

Description: The IP instruction resets the coordinates of P1 P2 scaling points.

New coordinates of P1 and P2 are designated by the plotter unit and must be within the effective plotting area. When the parameter designates out of the maximum effective plotting area, the error 3 is set and the instruction is ignored. The coordinates of P2 are omissible, but when it is omitted, the coordinates of P2 are changed according to P1 without changing the relative position.

When the IP instruction is executed without parameter, the coordinates of P1 and P2 are set at the initial positions corresponding to the current paper size.

When the valid IP instruction is received, set the bit 1 of the output status byte.

OP	The Output P1 and P2 Instruction

Format: OP terminator

Description: The OP instruction outputs current coordinates of P1 and P2 by the plotter unit.

The output is a 4-digit integer of ASCII. The format is as shown below.

TERM is the output terminator for the user system.

P1x,P1y,P2x,P2y TERM

The output value is limited by the maximum effective plotting area of the current selected paper size.

After completion of output, the bit 1 of the output status byte is cleared.

| **SC** | The Scale Instruction |

Format: SC Xmin, Xmax, Ymin, Ymax terminator or SC terminator

Description: The SC instruction sets the user unit coordinate system by allocating values on P1 and P2 scaling points.

When the user unit is set by execution of the SC instruction having parameters, the decimal part of the plotting instruction becomes effective. When it is executed without parameters, the scaling mode is reset and the parameters input thereafter will be interpreted as a plotter unit.

Parameters Xmin and Ymin define the user unit coordinate value of P1.

Parameters Xmax and Ymax define the user unit coordinate value of P2. When the parameter becomes Xmax = Xmin or Ymax = Ymin or smaller than -32,767 but larger than 32,767, the error 3 is set and the instruction is ignored.

When more than four parameters are input, the first four are executed and then, the error 2 is set and the remaining parameters are ignored.

| **IW** | The Input Window Instruction |

Format: IW Xlower left, Ylower left, Xupper right, Yupper right terminator or IW terminator

Description: The IW instruction sets the area called a window and limits the pen movable range.

Parameters are always interpreted as a plotter unit. When four parameters are included in the instruction, the window is set according to these parameters. However, when there is no parameter, it is set to the current maximum plotting area.

Each of four parameters designates the coordinates at the left below corner and right above corner of the window.

An effective parameter is a positive integer and within the maximum effective plotting area. However, parameters between –32,767 and 0 is set as 0. Parameters larger than the plotting area and smaller than 32,767 are set within the maximum effective plotting area.

When the coordinates at the left below corner is larger than that at the right above corner, it is automatically replaced.

By returning on the power switch, resetting of the front panel or execution of IN or DF instruction, the window is set within the current hard clip limit or the maximum plotting area.

| **OW** | The Output Window Instruction |

Format: OW terminator

Description: The OW instruction outputs the coordinates of the window area in which plotting is under executed.

The format is as shown below. Each is an integer value of ASCII.

      Xlower left, Ylower left, Xupper right, Yupper right TERM

TERM is the output terminator for the user system.

The integer value range is limited by the effective plotting area of the current selected paper size.

OH	The Output Hard-clip Limit Instruction

Format: OH terminator

Description: The OH instruction outputs the coordinates at the left below corner and right above corner of the current hard-clip limit.
The format is as shown below. Each is an integer value of ASCII.

Xlower left, Ylower left, Xupper right, Yupper right TERM

TERM is the output terminator for the user system.

RO	The Rotate Coordinates System Instruction

Format: RO (angle in degrees) terminator or RO terminator

Description: The RO instruction rotates the coordinate system of the plotter unit or user unit by 90°.
Valid parameters are 0 and 90 only. The "RO90:" instruction rotates the current coordinate system 90° from the initial direction.
Rotation is not accumulated and simply repeated ON and OFF.
The "RO0:" instruction is the same as "RO:", which turns off the rotation function.
Even if the "RO90:" instruction is executed, the coordinate values of P1 and P2 are held.
As a result of rotation, a part of the area may go out of the hard-clip limit. The window is also rotated and the part rotated out of the hardclip limit is cut out.
At this time, by executing the IW or IP instruction without parameters, the rotated initial coordinates are set.

Initial Coordinate Values of P1 and P2 Scaling Points after Rotation

Paper size	P_{1x}, P_{1y}	P_{2x}, P_{2y}
A	154 , 244	7354 , 10244
A4	0 , 610	7200 , 10610
B	283 , 934	10283 , 16134
A3	607 , 797	10607 , 15997

When parameters other than 0 and 90 are input, the error 3 is set and the instruction is ignored.
When there are too many parameters, the first parameter is executed and then, the error 2 is set and the remaining parameters are ignored.
It is also possible to turn on and off the rotation function from the front panel.
When ENTER and FAST keys are pressed simultaneously, the rotation function is turned on. Re-pressing these keys turns off the rotation function.
Unlike the RO instruction, rotation from the front panel automatically initializes the window or P1/P2 frame.

PU	PD	The Pen Instruction

Format: PU terminator or PD terminator or PU X,Y (,...) terminator or PD X,Y (,...) terminator

Description: PU and PD instructions execute pen up-down.

When there is no parameter in the PU instruction, the pen is raised without moving.

The PD instruction lowers the pen without moving it if the pen is in the window. If there is a parameter, the pen is raised or lowered and moved to the specified point.

Details will be described in the description of PA and PR instructions.

SP	The Select Pen Instruction

Format: SP pen number terminator or SP terminator

Description: The SP instruction selects the houses and pen. Parameters must be integers of $0 \leqq n \leqq 6$.

When the parameter is 0 or there is no parameter, the pen is housed in the carousel.

When the parameter is out of the range, the instruction is ignored and the pen is not replaced.

VS	The Velocity Select Instruction

Format: VS pen velocity terminator or VS terminator

Description: The VS instruction designates the pen down speed. When it is executed without parameter, it sets the pen speed to 40 cm/s and the acceleration to 1.0 g.

When a parameter is added, the pen speed in the vertical and horizontal directions is set to the value determined by the following equation.

$$Speed = 4 * (INT (V/4) + 1) (cm/s) (V: Pen velocity)$$

The parameter must be the number between 0 and 127.9999.

A negative value parameter or the parameter over 128 causes the error 3 and the speed is not changed.

The parameter between 40 and 127.9999 sets to the initial speed.

PA	The Plot Absolute Instruction

Format: PA X1, Y1 (, X2, Y2..., Xn, Yn) terminator or PA terminator

Description: The PA instruction moves the pen to the point designated by X and Y coordinates.

Valid parameters are real numbers between −32,767.0000 and +32,767.9999.

The decimal part is ignored when the scaling mode is off. When the instruction is executed without parameters, the absolute plot mode is set for the PU/PD instruction.

When parameters are added, both X and Y coordinates must be given.

If there is an extra parameter, an error is resulted. But, the preceding X and Y coordinates are plotted.

X and Y coordinates in the parameters designate the absolute coordinates of the destination point as a plotter unit or user unit.

When the scaling mode is on, the coordinates are interpreted as a user unit. When the scaling mode is off, it is interpreted as a plotter unit.

It is possible to insert PU or PD mnemonic before/after or between X and Y coordinates.

At this time, the PU raise the pen and the PD lowers it.

When the parameter to control the pen is not given, the pen is held in the state of the preceding statement.

The PU/PD mnemonic substitutes for the PA (or PR) mnemonic.

This means that the PU/PD instruction has the PA or PR instruction preceded. Therefore, the PU/PD having parameters is interpreted instead of PA or PR designated finally.

The absolute plot mode (PA) is designated by execution of any one of the following actions.

● Turn on the power switch or reset the front panel.
● Execute the IN, DF or PA instruction.

The pen moves to draw only within the window defined now. Parameters out of the range are ignored.

The pen state is unchanged and the error 3 is set. Vectors drawable by the PA instruction are available in the following four types.

	Last point		New point
(1)	From within the window	to	within the window
(2)	From within the window	to	out of the window
(3)	From out of the window	to	within the window
(4)	From out of the window	to	out of the window

(1) Moves the pen up and down as programmed from the last point to the new point.

(2) Move from the last point to the new point and stops at the boundary line of the window.

(3) The pen is moved in being raised to the crossing point with the boundary line of the window. When the pen reaches that point, pen is moved up and down as programmed and advances to the new point.

(4) The pen does not move out of the boundary line, but X and Y coordinates of the pen are updated. If a part of the vector is in the window area, the pen moves to the crossing point with the boundary line. Then, the pen moves to the crossing point between the vector and another window limit in the state as programmed, and stops and rises at this point.

* The point out of the range is ignored. Two points on both sides are connected.

PR	The Plot Relative Instruction

Format: PR ΔX1, ΔY1 (, ΔX2, ΔY2,... ΔXn, ΔYn) terminator or PR terminator

Description: The PR instruction moves the pen by the distance specified relatively with respect to the current position. Valid parameters are real numbers between –32,767.0000 and +32,767.9999.

When the scaling mode is off, the decimal part is ignored. When the instruction is executed without a parameter, the relative plot mode is set for the PU/PD instruction. When parameters are added, both X and Y travel distance must be given. If there is an extra parameter, an error is caused, but the preceding X and Y coordinates are plotted. The X travel designates the number of units moving in the X axis direction. The travel designates the number of units moving in the Y axis direction. The sign of the parameter determines the moving direction. Positive value means to move the pen in the positive direction. Negative value means to move the pen in the negative direction. The coordinates are interpreted as a user unit when the scaling mode is on and as a plotter unit when it is off. Like the PA instruction, mnemonics of PU and PD can be used as parameters to control the pen. When the parameter to control the pen is not given, the pen is held in the state of the preceding statement. PU and PD instructions substitute for the PR instruction. However, as the absolute plot mode (PA) is set when the power switch is turned on, the PR instruction must be executed for relative plotting. The relative plot mode (PR) is cancelled by execution of the PA, IN or DF instruction.

CI	The Circle Instruction

Format: CI radius (, chord angle) terminator

Description: The CI instruction draws a circle with specified radius and chord. Positive and negative integers or positive and negative scaled real numbers can be used for the radius. The sign determines the start point of drawing a circle. Start from the point of 0° for a positive radius and 180° for a negative radius. The current pen position is the center of circle. The radius is interpreted as a plotter unit when the scaling mode is off and as a user unit when it is on. If the user unit is not the same size in X and Y directions, an ellipse will be resulted.
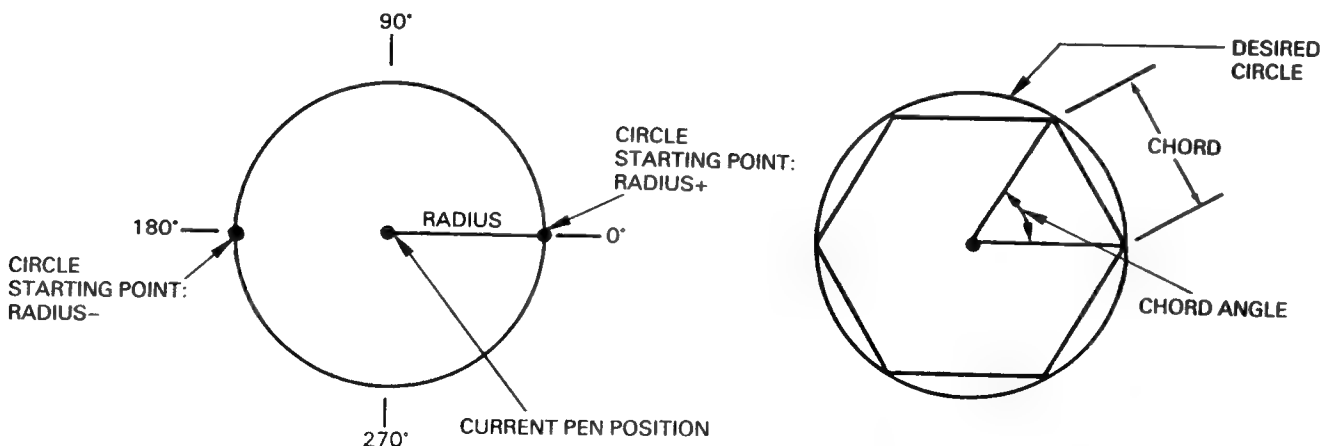
The chord angle is an integer and has an influence upon the smoothness of circle. It is interpreted as a degree and sets the maximum angle of chord. However, as all chords are set the same length, the actual length may be changed. The effective parameter range is –32,767 to +32,767, but the sign is ignored. The most useful angle is 0° to 180° for a negative radius. The current pen position is the center of circle. The radius is interpreted as a plotter unit when the scaling mode is off and as a user unit when it is on. If the user unit is not the same size in X and Y directions, an ellipse will be resulted. The chord angle is an integer and

has an influence upon the smoothness of circle. It is interpreted as a degree and sets the maximum angle of chord. However, as all chords are set the same length, the actual length may be changed. The effective parameter range is −32,767 to +32,767, but the sign is ignored. The most useful angle is 0° to 180°. The most smooth circle is generated at 0. As the degree becomes larger, the number of chords is decreased. The opposite tendency is seen in the range of 180 ∼ 360. As the degree is increased, the number of chords is also increased. The most smooth circle is generated with 360. Parameters out of the range are ignored and the error 3 is set for these parameters. The CI instruction has the automatic pen down function. Namely, when the pen is lowered after reception, it raises the pen and moves to the start point on the circumference and after circle is drawn, it lowers the pen and returns it to the center position. The pen is held in the preceding state. A circle is plotted within the defined window. The part going out of the window is cut off. Each chord of circle is drawn in the current selected line type.

AA	The Arc Absolute Instruction

Format: AA X, Y, arc angle (, chord angle) terminator

Description: The AA instruction draws an arc centering around the specified point. This instruction needs center coordinates, which is interpreted as a plotter unit when the scaling mode is off and as a user unit when it is on. The arc angle is an integer. Positive arc angle means to draw an arc in the counterclockwise direction from the current pen position. Negative arc angle means to draw an arc in the clockwise direction. The chord angle is also an integer. It has an influence upon the arc smoothness like the CI instruction. An arc is drawn in the preceding pen state and the line type. The error 3 is set for the parameters out of the range and the instruction is ignored.

CURRENT PEN POSITION

CHORD ANGLE

ABSOLUTE X, Y COORDINATES (ARC CENTER)
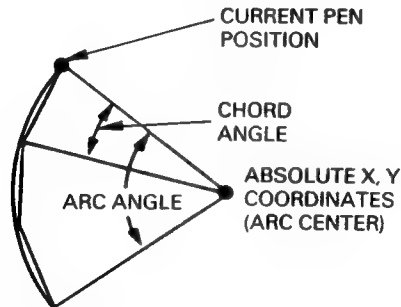
ARC ANGLE

AR	The Arc Relative Instruction

Format: AR ΔX, ΔY, arc angle (, chord angle) terminator

Description: The AR instruction needs the relative coordinates of ΔX and ΔY which define the center of arc (relative to the current pen position). It is interpreted as a plotter unit when the scaling mode is off and as a user unit when it is on. The sign determines the relative position of the center of arc. Namely, a positive value locates the center in the positive direction and a negative value locates it in the negative direction. The current pen position is the start point of drawing an arc. The arc angle is an integer. Positive arc angle is drawn in the counterclockwise direction from the current pen position. Negative arc angle is drawn in the clockwise direction. The chord angle is also an integer. It has an influence upon the smoothness of arc like the CI instruction. An arc is drawn in the preceding pen state and line type. The error 3 is set for the Parameters out of the range and the instruction is ignored.
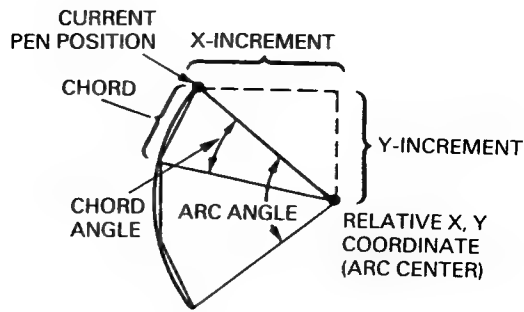
CURRENT PEN POSITION · X-INCREMENT · CHORD · Y-INCREMENT · CHORD ANGLE · ARC ANGLE · RELATIVE X, Y COORDINATE (ARC CENTER)

FT	The Fill Type Instruction

Format: FT (type (, spacing (, angle))) terminator of FT terminator

Description: The FT instruction is used together with the RA, RR or WG instruction for selecting the hatching type.

The hatching type is selectable in the following five types.

1. Painting out (Line spacing defined by the PT instruction: One-way drawing)
2. Painting out (Line spacing defined by the PT instruction: Two-way drawing)
3. Parallel lines (Line spacing defined by the FT instruction)
4. cross hatch (Line spacing defined by the FT instruction)
5. Ignore

The hatching type is usually an integer of 1 ~ 4. When it is not specified, the initial set value, type 1 is selected. Spacing is the distance between parallel lines and interpreted as a plotter unit when the scaling mode is off and as a user unit when it is on. When the spacing is not specified in the first FT instruction, 1% of the diagonal distance between scaling points P1 and P2 is used as an initial value. In the other cases, the value of the FT instruction is used. The value "0" is ignored and the value specified by the PT instruction is set. For types 1 and 2, this parameter is ignored and the value specified by the PT instruction is set. The angle is specified for each 0 to 45°. A horizontal line is drawn at 0; a vertical line at 90 and a slant line at 45°, respectively. When the angle is not specified in the first FT instruction, 0 is set, In the other cases, the value of the preceding FT instruction is used. When the parameter out of the range is specified, the error 3 is set and the instruction is ignored. When there are too many parameters, the error 2 is set, but the instruction is executed with the first three parameters and the other parameters are ignored.

PT	The Pen Thickness Instruction

Format: PT pen thickness terminator or PT terminator

Description: The PT instruction specifies the point out spacing.

The pen thickness indicates the pen width in millimeters. The parameter is 0.1 ~ 0.5 (mm). (The optimum range is 0.3 ~ 0.7 mm.) When it is not specified, the initial value is set to 0.3 (mm).

The error 3 is set for the parameters out of the range and the instruction is ignored. The error 2 is set when there are too many parameters, but the instruction is executed with the first one parameter and the other parameters are ignored.

The PT instruction has an influence upon the current selected pen only and keeps the value till the following actions are taken.

- Another pen is selected by the SP instruction.
- Another PT intsruction is given.

RA	The Shade Rectangle Absolute Instruction

Format: RA, X, Y terminator

Description: The RA instruction hatches the inside of the rectangle defined by the absolute coordinates.
It needs X and Y coordinates of user unit or plotter unit and defines a rectangle by these
points and the current pen position.
The parameter range is −32,767.0000 to +32,767.9999.
The decimal part is ignored when the scaling mode is off.
When there is no parameter, the instruction is ignored but an error is not generated.
The error 3 is set for the parameters out of the range and the instruction is ignored.
When there are too many parameters, the error 2 is set but the instruction is executed with
the first two parameters and the other parameters are ignored.
The rectangle is hatched using the current selected pen and the line type.
When the instruction is completed, the pen returns to the previous position and state.

EA	The Edge Rectangle Absolute Instruction

Format: EA X, Y terminator

Description: The EA instruction frames the rectangle defined by absolute coordinates.
This instruction needs X and Y coordinates of user unit or plotter unit and defines a rectangle
by these points and the current pen position.
The parameter range is −32,767.0000 to +32,767.9999.
The decimal part is ignored when the scaling mode is off.
When there is no parameter, the instruction is ignored but an error is not generated.
For the parameters out of the range, the error 3 is set and the instruction is ignored. When
there are too many parameters, the error 2 is set but the instruction is executed with the first
two parameters and the other parameters are ignored.
When the instruction is completed, the pen returns to the original position and state.

RR	The Shade Rectangle Relative Instruction

Format: RR ΔX, ΔY terminator

Description: The RR instruction hatches the inside of the rectangle defined by relative coordinates.
This instruction needs ΔX and ΔY coordinates of user unit or plotter unit and defines a rec-
tangle by the points specified by these coordinates and the current pen position. The para-
meter range is −32,767.0000 to +32,767.9999. The decimal part is ignored when the scal-
ing mode is off. When there is no parameter, the instruction is ignored but an error is not
generated. For the parameters out of the range, the error 3 is set and the instruction is ig-
nored. When there are too many parameters, the error 2 is set but the instruction is execut-
ed with the first two parameters and the other parameters are ignored. A rectangle is
hatched using the current selected pen and line type. When the instruction is completed, the
pen returns to the original position and state.

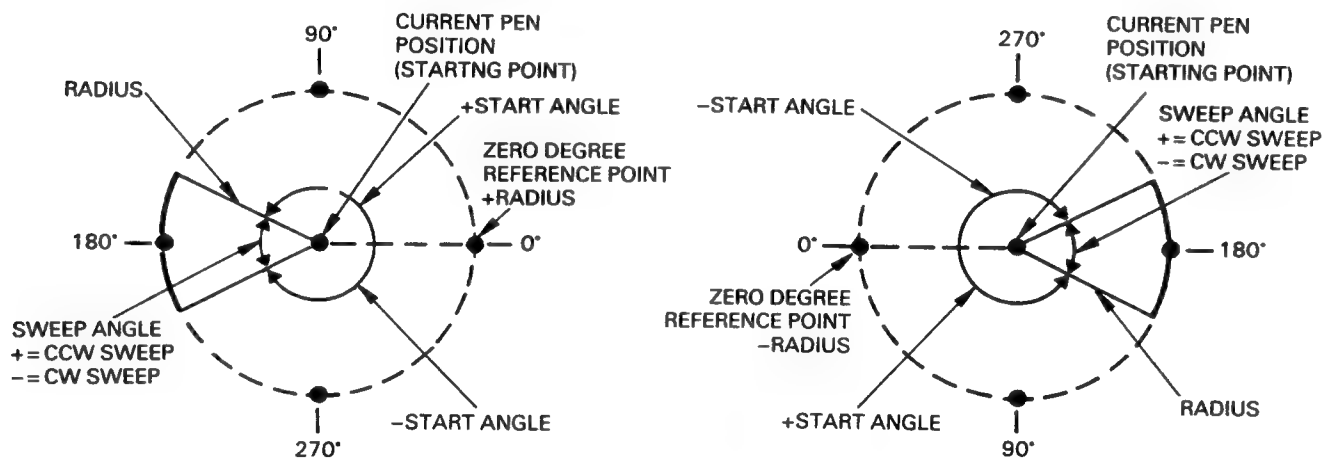| **ER**	The Edge Rectangle Relative Instruction

Format: ER ΔX, ΔY terminator

Description: The ER instruction frames the rectangle defined by relative coordinates.
This instruction needs ΔX and ΔY coordinates of user unit or plotter unit and defines a rectangle by the points specified by these coordinates and the current pen position. The parameter range is −32,767.0000 to +32,767.9999. The decimal part is ignored when the scaling mode is off. When there is no parameters, the instruction is ignored but an error is not generated. For the parameters out of the range, the error 3 is set and the instruction is ignored. When there are too many parameters, the error 2 is set but the instruction is executed with the first two parameters and the other parameters are ignored. When the instruction is completed, the pen returns to the original position and state.

WG	The Shade Wedge Instruction

Format: WG radius, start angle, sweep angle (, chord angle) terminator

Description: The WG instruction hatches the inside of a wedge centering around the current pen position by using the current specified pen and line type.

CURRENT PEN POSITION (STARTNG POINT)
+START ANGLE
ZERO DEGREE REFERENCE POINT +RADIUS
RADIUS
SWEEP ANGLE += CCW SWEEP −= CW SWEEP
−START ANGLE

CURRENT PEN POSITION (STARTING POINT)
SWEEP ANGLE += CCW SWEEP −= CW SWEEP
−START ANGLE
ZERO DEGREE REFERENCE POINT −RADIUS
+START ANGLE
RADIUS

The radius determines the wedge size. The sign defines the 0° position for start angle and sweep angle. The parameter is the user unit or plotter unit. The decimal part is ignored when the scaling mode is off. When the scaling mode is on, it is interpreted as an X-axis user unit. The start angle is an integer and specifies the position of drawing the first radius. The first radius is drawn counterclockwise from the 0° point when the start angle is a positive number and clockwise from the 0° point when the start angle is a negative number. The value greater than 360° is converted to 360° or less. The sweep angle is an integer and specifies the arc angle. The arc is drawn in the counterclockwise direction when the sweep angle is a positive number and in the clockwise direction when the sweep angle is a positive number. When the value greater than 360° is specified, 360° is used instead. The chord angle is an integer of 1 to 120 and defines the arc smoothness. However, when the number of chords is over 72, 5° is automatically set. When the value of integer multiple of the chord angle is not equal to the sweep angle, change the chord angle to the most close integer to make all chord lengths equal. When the instruction is completed, the pen returns to the original position and state. The WG instruction is not executed without parameters and an error is not generated. For the parameters out of the range, the error 3 is set and the instruction is ignored. When the number of parameters is too small, the error 2 is set and the instruction is ignored. When there are too many parameters, the error 2 is set but the instruction is executed with the first four parameters and the other parameters are ignored.

EW	The Edge Wedge Instruction

Format: EW radius, start angle, sweep angle (, chord angle) terminator

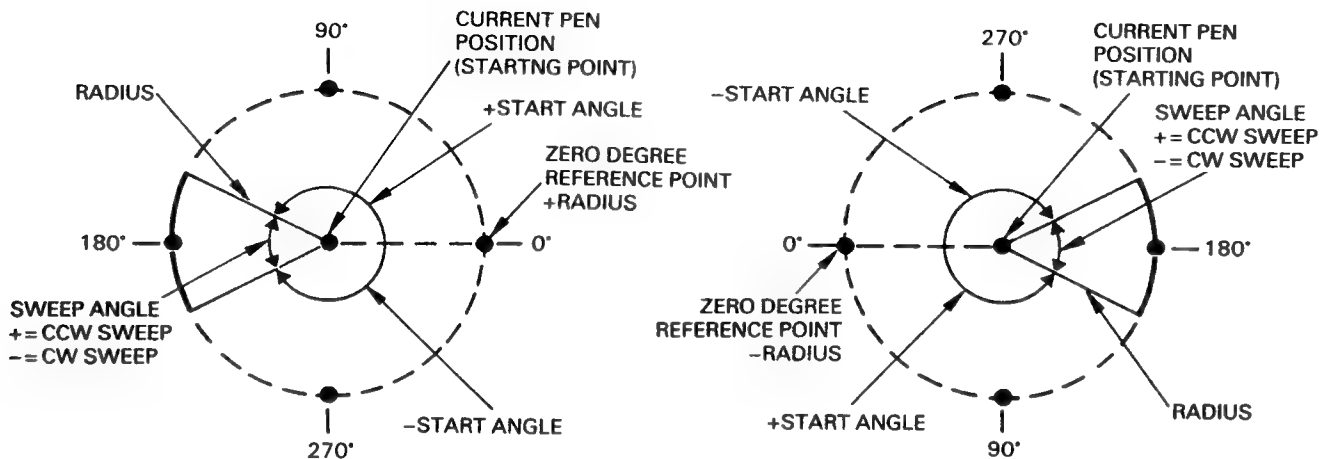**Description:** The EW instruction frames the wedge drawn centering around the current pen position using the current specified pen and line type. For the parameters, refer to the WG instruction.

XT	YT	The Tick Instruction

Format: XT terminator or YT terminator

Description: The XT instruction draws the X-axis tick of vertical direction at the current position.

The YT instruction draws Y-axis tick of horizontal direction at the current position. When a parameter is added, the error 2 is set and the instruction is ignored.

The tick length is specified by the TL instruction. If the tick length is not specified, 0.5% of (P2x – P1x) and 0.5% of (P2y – P1y) are set for the positive and negative parts of the tick.

TL	The Tick Length Instruction

Format: TL tp (, tn) terminator or TL terminator

Description: The TL instruction specifies the tick length.

The tick length is specified as a ratio of vertical and horizontal distances between scaling points P1 and P2.

Two parameters must be between –128.000 and +127.9999. In many applications, it is used between 0 and 100. The tp determines the lengths of the upper side part drawn along the X axis and the right side part drawn along the Y axis when the P1 is seen as a point at the left below corner.

The tn determines the lengths of the lower side part drawn along the X axis and the left side part drawn along the Y axis.

When the plotter is initialized or the TL instruction is executed without parameters, the tick length is automatically set to 0.5% of (P2x – P2x) and 0.5% of (P2y – P1y).

When only one parameter is specified, the tp is set and the tn becomes 0. Once the TL instruction is set, it is held unitl another TL instruction executed or the IN or DF instruction is executed.

SM	The Symbol Mode Instruction

Format: SM c terminator or SM terminator

Description: The SM instruction is used together with the PA or PR instruction for drawing a single character centering around the vector end point.

The first character after the mnemonic is set as a symbol. When a parameter is not added, the symbol mode is set to off. The function of PA or PR instruction succeeding execution of the SM instruction having effective parameters is the additional function of drawing the specified symbol at the end of the vector.

Character printing is regardless of the current pen state and usually drawn at each point specified by PA and PR instructions (centering around the point).

The SM instruction state is held until another effective SM instruction state is exeuted or the IN or DF instruction is executed. Drawn characters are influenced by SI, SR, SL, DI and DR instructions. The SM instruction can specify several characters (33 to 126 in decimal ASCII), but a semicolon (59 in decimal ASCII) is used to turn off the symbol mode (SM;) and not selected as a symbol drawn at each end point.

The symbol mode is also turned off when a space (32 in decimal ASCII) or other control characters are specified.

LT	The Line Type Instruction

Format: LT pattern number (, pattern length) terminator or LT terminator

Description: The LT instruction specifies the line type used in PA and PR instructions.
Type numbers and patterns are shown below.


```
0 — specifies dots only at the points that are plotted.
1 — .      .      .      .      .      .      .      .
2 — __   __   __   __   __   __   __   _
3 — ___  ___  ___  ___  ___  ___  ___ __
4 — ____.____.____.____.____.____.____..
5 — ___._.___._.___._.___.__._.___._.__.__
6 — ___.__.___.__.___.__.___.__.___.__.___.__
        |____|____ One pattern length
No parameter    _____
```

The pattern number is a real number between –128.0000 and +127.9999. The decimal part is ignored. When a parameter of 0 ~ 6 is added, the corresponsing line type is set. However, when 7 or higher number is specified, it is ignored and the line type is unchanged. A negative parameter is set for a solid line. For the parameters out of the range, the error 3 is set and the instruction is ignored. The line pitch parameter is a real number between –128.0000 and +127.9999 (the decimal part is also effective), which specifies the one pattern length as a ratio of orthogonal distance between P1 and P2. When the parameter is negative or over 128, the error 3 is set and the preceding length is specified for the line pitch. When the parameter is omitted, the initial value is set to 4%.

| CS | The Designate Standard Character Set Instruction |

Format: CS set number terminator

Description: The CS instruction selects one of 19 character sets (0 ~ 4, 6 ~ 9 and 30 ~ 39) as a standard character set.

The standard character set designated by the CS instruction can be used for all character strings when it is selected by the SS instruction or SI code (15 in the decimal ASCII).

When the unit is initialized or set for the first time, the 0 character set is automatically designated. When the CS instruction is executed while the standard character set is being selected, the character set used for character string operation is immediately changed.

However, even if the CS instruction is executed while the alternate character set is being selected, that character set will not be changed until the standard charcter set is selected.

When no parameter is added, 0 is set. For the CS instruction having ineffective parameters, the error 5 is set and the instruction is ignored.

| CA | The Designate Alternate Character Set Instruction |

Format: CA set number terminator

Description: The CA instruction selects one of 19 character sets (0 ~ 4, 6 ~ 9 and 30 ~ 39) as an alternate character set.

The alternate character set designated by the CA instruction can be used for all character strings when it is selected by the SA instruction or SO code (14 in the decimal ASCII). When the unit is initialized or set for the first time, the 0 character set is automatically designated. When the CA instruction is executed while the alternate character set is being selected, the character set used for the character string operation is immediately changed.

However, even if the CA instruction is executed while the standard character set is being selected, that character set will not be changed until the alternate character set is selected.

When no parameter is added, 0 is set. For the CA instruction having ineffective parameters, the error 5 is set and the instruction is ignored.

| SS | The Selected Standard Set Instruction |

Format: SS terminator

Description: The SS instruction selects the standard character set designated by the CS instruction as a character set usable for all character operations.

When parameters are added, the error 2 is set and the standard character set is selected.

At power on, initialization or initial setting, the standard character set (0 set) is automatically selected.

When the SI code (15 in the decimal ASCII) is transmitted in the label instruction, the standard character set is selected.

SA	The Selected Alternate Set Instruction

Format: SA terminator

Description: The SA instruction selects the alternate character set designated by the CA instruction as a character set usable for all character operations.

When the character string in the label instruction uses the alternate character set, the SA instruction is executed beforehand.

At power on, initialization or initial setting, the standard character set (0 set) is automatically set.

When the SO code (14 in the decimal ASCII) is transmitted in the label instruction, the alternate character set is selected.

DT	The Define Terminator Instruction

Format: DT t terminator (t: Label terminator)

Description: The DT instruction designates the label terminator character.

The label mode is terminated by transmitting the label terminator. The ASCII control code (1 - 32 and 127 in the decimal ASCII) can be defined as a label terminator and when it is executed, printing is not made. However, the function of the code itself is not lost.

For example, when LF (10 in the decimal ASCII) is designated, line feeding is executed.

Characters 33 to 126 in the decimal ASCII can also be defined as a label terminator, but in that case, printing is made at the end of character string.

The control code which is 0 in the decimal ASCII cannot be defined as a label terminator.

Note: The character succeeding the DT mnemonic is interpreted as a parameter.

The "DT" instruction does not restore ETX as a label terminator.

To restore ETX as a label terminator, execute the ETX itself or execute the DF or IN instruction.

Terminator Character List

33	!	50	2	65	A	78	N	97	a	110	n
34	"	51	3	66	B	79	O	98	b	111	o
37	%	52	4	67	C	80	P	99	c	112	p
38	&	53	5	68	D	81	Q	100	d	113	q
40	(	54	6	69	E	82	R	101	e	114	r
41	)	55	7	70	F	83	S	102	f	115	s
42	*	56	8	71	G	84	T	103	g	116	t
43	+	57	9	72	H	85	U	104	h	117	u
44	,	58	:	73	I	86	V	105	i	118	v
45	_	59	;	74	J	87	W	106	j	119	w
46	.	60	<	75	K	88	X	107	k	120	x
47	/	61	=	76	L	89	Y	108	l	121	y
48	0	62	>	77	M	90	Z	109	m	122	z
49	1	63	?								

The above table lists the characters which can be designated for the terminator with respect to all character sets except for 7 and 8. If the user does not designate the character common to all character sets as a label terminator, the label mode cannot be released if the terminator is change simultaneously the character set.

LB	The Label Instruction

Format: LB c ... ct (t: Label terminator)

Description: The LB instruction prints texts and characters.

The character string succeeding the mnemonic LB is printed using the character set under selected now. The character set to be used is designated by the CA or CS instruction and selected by the SA or SS instruction or by the ASCII control code.

When there is not designation, the 0 character set is set. The character direction, size and tilt are previously designated by the DR, DI, SR, SI or SL instruction.

If not, the initial values are set. As the character is drawn at the current pen position, move the pen to the desired position using the PA or PR instruction or the manual pen mode function before using the LB instruction.

This point is the left below corner of the first character and the return position when the line is fed.
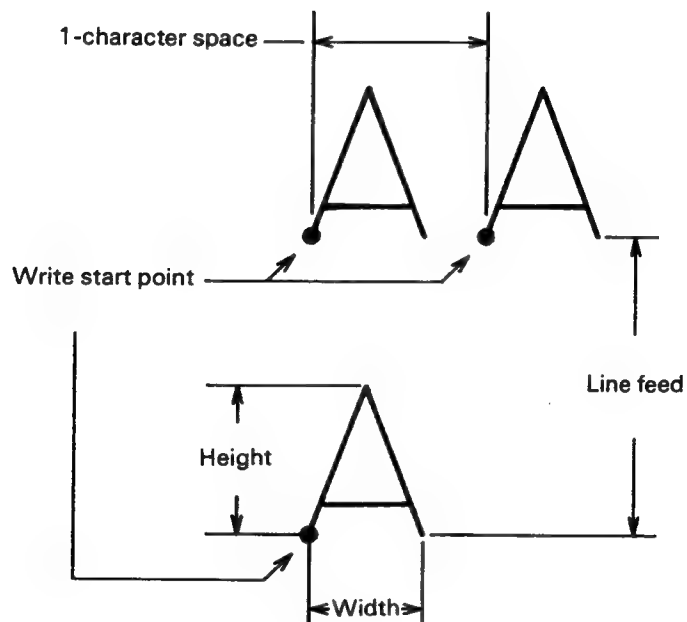
When the carriage return is received during the label mode, the pen returns to the line feed point. The line feed point is influenced by the DI or DR instruction or the control from the front panel.
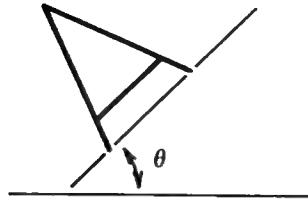
DI	The Absolute Direction Instruction

Format: DI run, rise terminator or DI terminator

Description: The DI instruction designates the character direction.

Run and rise are real numbers of -128.0000 to $+127.9999$, which determine the direction according to the following relationship.

$$\theta = \tan^{-1} (rise/run)$$

$$rise = SIN\,(\theta)$$
$$run = COS\,(\theta)$$

Printing is made in the horizontal direction when the rise is 0° and in the vertical direction when the run is 0.

When the instruction has no parameter, DI1,0 is set. When the number of parameters is too small, the error 2 is set and the instruction is ignored.

When there are too many parameters, the error 2 is set but the instruction is executed with the first two parameters and the other parameters are ignored.

The DI instruction state is held until another DI.DR or IN.DF instruction is executed or the plotter is reset on the front panel. The DI instruction updates the line feed point to the current pen position.

DR	The Relative Direction Instruction

Format: DR run, rise terminator or DR terminator

Description: The DR instruction designates the character direction. Run and rise are real numbers of -128.0000 to $+127.9999$, which determine the direction according to the following relationship.

$$\theta = \tan^{-1} (rise/run)$$
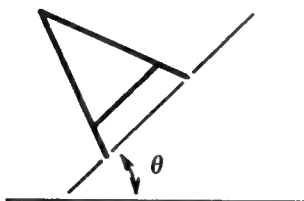
$$rise = SIN\,(\theta)$$
$$run = COS\,(\theta)$$

Rise and run designate the ratio of orthogonal distance between P1 and P2. The run is the ratio against (P2x – P1x) and the rise is the ratio against (P2y – P1y).

Therefore, when the P1/P2 frame is changed, the character direction is also changed. Printing is made in the horizontal direction when the rise is 0 and in the vertical direction when the run is 0.

When the instruction has no parameter, DR1,0 is set. When the number of parameters is too small, the error 2 is set and the instruction is ignored. When there are too many parameters, the error 2 is set but the instruction is executed with the first two parameters and the other parameters are ignored.

The DR instruction state is held until another DI.DR or IN.DF instruction is executed or the plotter is reset on the front panel. The DR instruction updates the line feed point to the current pen position.

CP	The Character Plot Instruction

Format: CP tw, th terminator or CP terminator

Description: The CP instruction moves the pen by the distance equivalent to the designated number of characters.

When no parameter is added, carriage return and line feed are executed. The line feed point is the point designated finally by execution of PA, PR, PU or PD instruction or execution of the manual move function or execution of DI or DR instruction.

SI	The Absolute Character Size Instruction

Format: SI width, height terminator or SI terminator

Description: The SI instruction sets the character or symbol size in centimeter units.

Parameters are real numbers of -128.0000 to $+127.9999$, which determine the character width and height. When no parameter is added, it is set as follows.

Paper size	Width	Height
A/A4	0.187	0.269
B/A3	0.285	0.375

When the number of parameters is too small, the error 2 is set and the instruction is ignored. When there are too many parameters, the error 2 is set but the instruction is executed with the first two parameters and the other parameters are ignored.

The SI instruction state is held until another SI.SR or IN.DF instruction is executed or the plotter is reset on the front panel.

SR	The Relative Character Size Instruction

Format: SR width, height terminator or SR terminator

Description: The SR instruction sets the character or symbol size by the ratio of orthogonal distance between P1 and P2.

Parameters are real numbers between -128.0000 and $+127.9999$, which determine the character height and width. When no parameter is added, the width is set to 0.75 (%) and the height 1.5 (%).

When the number of parameters is too small, the error 2 is set and the instruction is ignored. When there are too many parameters, the error 2 is set but the instruction is executed with the first two parameters and the other parameters are ignored.

The SI instruction state is held until another SI.SR or IN.DF instruction is executed or the plotter is reset on the front panel.

SL	The Character Slant Instruction

Format: SL tan (θ) terminator or SL terminator

Description: The SL instruction designates the character slant angle. The parameter is interpreted as an angle tangent from the vertical direction.

When there are too many parameters, the error 2 is set but the instruction is executed with the first parameter and the other parameters are ignored. When there is no parameter, the same value as SL0 is set and the character is not slanted.

The SL instruction state is held until another SL or IN.DF instruction is executed or the plotter is reset on the front panel.

UC	The User-Defined Character Instruction

Format: UC (pen,) ΔX, ΔY, (pen,)(ΔX,ΔY,) ..., ..., terminator or UC terminator

Description: The UC instruction draws the characters designed by the user.

Characters are drawn on the grids which divides the character base area into 6 divisions in the horizontal direction and 16 divisions in the vertical direction. The character space area is twice the current character height and 1.5 times the width.

When it is desired to make the character the same size as that drawn by the label instruction, design it within 4 grids in the axial direction and 8 grids in the height direction taking the left below corner of grid as a start point.

The user defined characters are drawn according to the following rules.

● Each X and Y travel is drawn in the latest pen control parameter state.
When the UC instruction is received, the plotter raises the pen and set the current position at the grid point (0, 0).

● The pen moves to the point designated by X and Y travels.
X and Y travels are real numbers between –98.9999 and +98.9999, which designate the number of basic grids which the pen moves from the current position.
The moving direction is relative to the current character direction.

● Pen control parameters are as follows.
     pen > +99 — Pen down
     pen > –99 — Pen up

When no parameter is added, the pen is moved to the line feed point. When the pen down parameter is given, that state is held until the pen up parameter is given or the instruction is completed. When the instruction is completed, the pen moves to the next character start point in being raised and restores the latest PU.PD instruction state.

The user defined characters are drawn in the current character size, tilt and direction.

For unsuitable X and Y travels, the error 2 is set and the instruction is ignored.

For the others, the characters are drawn.

For the parameters out of the range, the error 3 is set.

DP	The Digitize Point Instruction

Format: DP terminator

Description: The DP instruction digitizes a desired point.

When the instruction is received, the automatic pen up function stops for a while and the PAUSE indicator starts blinking. At this time, move the pen to the desired position and press the ENTER key.

When the ENTER key is pressed, the coordinates of that point and the pen state are stored and the bit 2 of the status byte is set.

After the ENTER key is pressed, the automatic pen up function is recovered and the PAUSE indicator stops blinking. The digitized point is output by the OD instruction.

DC	The Digitize Clear Instruction

Format:　　　 DC terminator

Description:　The DC instruction terminates the digitize mode.

　　　　　　　 At the same time, it recovers the automatic pen up function and stops blinking of the
　　　　　　　 PAUSE indicator.

OD	The Output Digitize Point and Pen Status Instruction

Format:　　　 OD terminator

Description:　The OD instruction outputs the coordinates of the finally digitized point and the pen status.

　　　　　　　 The output is an integer of ASCII and the format is as shown below.

<div align="center">X, Y, P TERM</div>

X and Y are X and Y coordinates (plotter unit) of the digitized point. P indicates the pen status at the input time (0 = pen up, 1 = pen down).

When the OD instruction is received, the bit 2 of the output status byte is cleared.

OA	The Output Actual Position and Pen Status Instruction

Format:　　　 OA terminator

Description:　The OA instruction outputs the coordinates of the current pen position and status.

　　　　　　　 The output is an integer of ASCII and the format is as shown below.

<div align="center">X, Y, P TERM</div>

X and Y are X and Y coordinates (plotter unit). P indicates the pen status (0 = pen up, 1 = pen down).

TERM is the output terminator.

OC	The Output Commanded Position and Pen Status Instruction

Format:　　　 OC terminator

Description:　The OC instruction outputs the coordinates designated by the finally input instruction and the pen status.

　　　　　　　 The output is a real number of ASCII (user unit when the scaling mode is on and the plotter unit when it is off) and the format is as shown below.

<div align="center">X, Y, P TERM</div>

X and Y are X and Y coordinates (plotter unit or user unit).

P indicates the pen status (0 = pen up, 1 = pen down).

TERM is the output terminator.

OE	The Output Error Instruction

Format: OE terminator

Description: The OE instruction outputs the first SK-GL error number as a decimal ASCII.

The format is as shown below.

<div align="center">error number TERM</div>

TERM is the output terminator. The error number is defines as shown in the following table.

Error No.	Meaning
0	No error
1	Undefined instruction
2	Abnormal parameter number
3	Abnormal parameter
4	Not used
5	Undefined character set 6 Position overflow
7	Not used
8	Reception of vector and PD (at the pinchwheel up)

OF	The Output Factors Instruction

Format: OF terminator

Description: The OF instruction outputs the number of plotter unit per 1 mm.

The plotter usually outputs as shown below.

<div align="center">40, 40 TERM</div>

TERM is the output terminator.

OI	The Output Identification Instruction

Format: OI terminator

Description: The OI instruction outputs the registered number of the plotter.

The plotter usually outputs as shown below.

<div align="center">SPL-430 TERM</div>

TERM is the output terminator.

OO	The Output Option Instruction

Format: OO terminator

Description: The OO instruction outputs 8 option parameters.

The plotter usually outputs as shown below.

<div align="center">0,1,0,0,1,0,0,0 TERM</div>

TERM is the output terminal.

| OS | The Output Status Instruction |

Format: OS terminator

Description: The OS instruction outputs the status byte as a decimal ASCII.

The format is as shown below.

<div align="center">status TERM</div>

TERM is the output terminator.

The status byte is defined as shown below.

Bit value	Bit	Meaning
1	0	Pen down
2	1	P1/P2 change
4	2	Digitize point
8	3	Initialize
16	4	Reception enabled (pinchwheel down)
32	5	Error
64	6	Not used
128	7	Not used

When the power is turned on, the sum of 8 plus 16, 24 is set. After the status byte is output, the bit 3 is cleared.

7-4. RS-232-C control instructions

When plotting is made using the RS-232-C interface, the handshaking method must be determined for data transfer.

For the purpose of setting them, the instructions with ESC (escape) are contained as explained below.

Use a semicolon (;) for the delimiter of parameters included in each instruction and use a colon (:) for the terminator.

When the parameter is omitted and the delimiter is continues, the initial value is set.

ESC.@	The Set Plotter Configuration Instruction

Format: ESC.@ [; (< DEC >)]:

Description: The DTR control is disabled when the DEC parameter is 0 and enabled when it is 1.

When the DTR control is disabled, the DTR signal is usually positive potential.

When the power switch is turned on, the DTR control is set.

"ESC.@ ;0:" disables the DTR control.

ESC. I	The Set Handshake Mode Instruction

Format: ESC. I [; ; (< ASC >) (; . . . ; < ASC >))]:

Description: The ASC parameter is a decimal ASCII and sets the Xon trigger character.

This parameter can be input up to ten by delimiting with semicolons.

Effective parameters are 0 ~ 127. 0 is not transferred and the succeeding characters are not output.

"ESC. I ; ; 17:" sets the Xon trigger character in DC1.

Threshold level of buffer memory

Buffer memory size . . . 1024 bytes

Xon threshold level . . . 512 bytes

Xoff threshold level . . . 128 bytes

ESC. N	The Set Xoff Trigger Character Instruction

Format: ESC. N [; (< ASC > (; . . . ; < ASC >))]:

Description: The ASC parameter is a decimal ASCII and sets the Xoff trigger character.

This parameter can be input up to ten by delimiting with semicolons.

Effective parameters are 0 ~ 127.

0 is not transferred and the succeeding characters are not output.

"ESC. N ; 19:" sets the Xoff trigger character in DC3.

ESC. M	The Set Output Mode Instruction

Format: ESC. M [(< DEC >) ; ; ; (< ASC > (; (< ASC >))]:
Description: The DEC parameter sets the wait time at data output.
              The parameter is assumed as T.

$$TIME = (((T * 1.1875) \bmod 65536) / 1.2) * 10^{-3} \ sec$$

The decimal part of the parameter is ignored.
The < ASC > (; (< ASC >)) parameter determines the output terminator comprising one or two and designates it as an equivalent decimal value for the ASCII character.
In the initial state, the carriage return (13 in the decimal ASCII) is used.
0 is not output in the decimal ASCII.
"ESC. M500 ; ; ; 13 ; 10:" sets the wait time of about 500ms at the output and designates the output terminator for carriage return and line feed.

ESC. R	The Reset Handshake Instruction

Format: ESC. R
Description: When the current handshake mode is the X parameter control, all setting is reset by this instruction and the DTR control mode is set.

Turnaround delay	: 0
Output terminator	: 13 ; 0:
Hardwire handshake mode (pin 20)	: enabled

7-5. ASCII Control Codes

Decimal value	ASCII	Operation contents
0	NULL	No operation
1	SOH	No operation
2	STX	No operation
3	ETX	Label terminator
4	ETO	No operation
5	ENQ	No operation
6	ACK	No operation
7	BEL	No operation
8	BS	Back space
★ 9	HT	Horizontal tab (1/2 back space)
10	LF	Line feed
11	VT	Inverse line feed
12	FF	No operation
13	CR	Carriage return
14	SO	Select alternate character set
15	SI	Select standard character set
16	DLE	No operation
17	DC1	No operation
18	DC2	No operation
19	DC3	No operation
20	DC4	No operation
21	NAK	No operation
22	SYN	No operation
23	ETB	No operation
24	CAN	No operation
25	EM	No operation
26	SUB	No operation
27	ESC	No operation
28	FS	No operation
29	GS	No operation
30	RS	No operation
31	US	No operation
32	SP	Space

★ For the horizontal tab, move the pen 1/2 character backward. This is the function equivalent to "CP-.5,0; in the command. It is mainly used for katakana of the character set 8 and effective for justifying the space between the character such as a voiced sound and the preceding character.

8. SPECIFICATIONS

Maximum plotting area	: X-axis: 416 mm Y-axis: 276 mm
Maximum plotting speed	: 400 mm/sec (axial direction)
	565 mm/sec (45° direction)
Step size	: 0.025 mm
Distance accuracy	: ±(0.2 + 0.3% of travel distance) mm
Repeatability (samepen)	: 0.3 mm or less
(pen to pen)	: 0.4 mm or less
Number of pens	: 6
Pen types	: Water based fiber-tip pens (6 colors: Red, black, blue, green, brown and orange)
	Oil based fiber-tip pen (Option)
Paper size	: ISO standard A4 and A3
	ANSI standard A and B
Operating conditions	: Ambient temperature; +5° – +35°C
	Relative humidity; 35 – 75%
Power requirements	: 100/120/220/240 V AC ±10% (50/60Hz)
	Specify upon placing an order.
Power consumption	: 50 V A or less
External dimensions	: 492 (W) × 302 (D) × 117 (H) mm
Weight	: Approx. 7 kg
Interface	: Serial interface (conformable to RS-232C) and optional 8-bit parallel (conformable to CENTRONICS) or GP-IB (conformable to IEEE-488).

The specifications in this manual subject to change without notice.

9. APPENDIX

9-1. Character Set

Set	Type	ISO register No.
0	ANSI ASCII	006
1	9825 character set	———
2	French/German	———
3	Scandinavian	———
4	Spanish/Latin American	———
6	JIS ASCII	014
7	Roman 8 Extensions	———
8	Katakana	013
9	ISO IRV	002
30	ISO Swedish	010
31	ISO Swedish For Names	011
32	ISO Norway, Version 1	060
33	ISO German	021
34	ISO French	025
35	ISO United Kingdom	004
36	ISO Italian	015
37	ISO Spanish	017
38	ISO Portuguese	016
39	ISO Norway, Version 2	061

DECIMAL VALUE	SET																		
	0	1	2	3	4	6	7	8	9	30	31	32	33	34	35	36	37	38	39
33	!	!	!	!	!	!	λ	·	!	!	!	!	!	!	!	!	!	!	!
34	"	"	"	"	"	"	Â	「	"	"	"	"	"	"	"	"	"	"	"
35	#	#	£	£	¿	#	È	」	#	#	#	#	#	£	£	£	£	#	§
36	$	$	$	$	$	$	Ê	、	¤	¤	¤	$	$	$	$	$	$	$	$
37	%	%	%	%	%	%	Ë	・	%	%	%	%	%	%	%	%	%	%	%
38	&	&	&	&	&	&	Î	ヲ	&	&	&	&	&	&	&	&	&	&	&
39	·	·	´	·	´	·	Ï	ァ	·	·	·	·	·	·	·	·	·	·	·
40	(	(	(	(	(	(	´	ィ	(	(	(	(	(	(	(	(	(	(	(
41	)	)	)	)	)	)	`	ゥ	)	)	)	)	)	)	)	)	)	)	)
42	*	*	*	*	*	*	^	ェ	*	*	*	*	*	*	*	*	*	*	*
43	+	+	+	+	+	+	¯	ォ	+	+	+	+	+	+	+	+	+	+	+
44	.	.	.	.	.	.	~	ャ	.	.	.	.	.	.	.	.	.	.	.
45	—	—	—	—	—	—	Ù	ュ	—	—	—	—	—	—	—	—	—	—	—
46	.	.	.	.	.	.	Ô	ョ	.	.	.	.	.	.	.	.	.	.	.
47	/	/	/	/	/	/	£	ッ	/	/	/	/	/	/	/	/	/	/	/
48	0	0	0	0	0	0	¯	ー	0	0	0	0	0	0	0	0	0	0	0
49	1	1	1	1	1	1		ア	1	1	1	1	1	1	1	1	1	1	1
50	2	2	2	2	2	2		イ	2	2	2	2	2	2	2	2	2	2	2
51	3	3	3	3	3	3	·	ウ	3	3	3	3	3	3	3	3	3	3	3
52	4	4	4	4	4	4	Ç	エ	4	4	4	4	4	4	4	4	4	4	4
53	5	5	5	5	5	5	ç	オ	5	5	5	5	5	5	5	5	5	5	5
54	6	6	6	6	6	6	Ñ	カ	6	6	6	6	6	6	6	6	6	6	6
55	7	7	7	7	7	7	ñ	キ	7	7	7	7	7	7	7	7	7	7	7
56	8	8	8	8	8	8			ク	8	8	8	8	8	8	8	8	8	8	8
57	9	9	9	9	9	9	¿	ケ	9	9	9	9	9	9	9	9	9	9	9
58	:	:	:	:	:	:	¤	コ	:	:	:	:	:	:	:	:	:	:	:
59	;	;	;	;	;	;	£	サ	;	;	;	;	;	;	;	;	;	;	;
60	<	<	<	<	<	<	¥	シ	<	<	<	<	<	<	<	<	<	<	<
61	=	=	=	=	=	=	§	ス	=	=	=	=	=	=	=	=	=	=	=
62	>	>	>	>	>	>	ƒ	セ	>	>	>	>	>	>	>	>	>	>	>
63	?	?	?	?	?	?	¢	ソ	?	?	?	?	?	?	?	?	?	?	?
64	@	@	@	@	@	@	â	タ	@	@	É	@	§	à	@	§	§	§	@

DECIMAL VALUE	SET 0	1	2	3	4	6	7	8	9	30	31	32	33	34	35	36	37	38	39
65	A	A	A	A	A	A	ê	ƒ	A	A	A	A	A	A	A	A	A	A	A
66	B	B	B	B	B	B	ô	ツ	B	B	B	B	B	B	B	B	B	B	B
67	C	C	C	C	C	C	Ù	テ	C	C	C	C	C	C	C	C	C	C	C
68	D	D	D	D	D	D	á	ト	D	D	D	D	D	D	D	D	D	D	D
69	E	E	E	E	E	E	é	ナ	E	E	E	E	E	E	E	E	E	E	E
70	F	F	F	F	F	F	ó	ニ	F	F	F	F	F	F	F	F	F	F	F
71	G	G	G	G	G	G	ú	ヌ	G	G	G	G	G	G	G	G	G	G	G
72	H	H	H	H	H	H	à	ネ	H	H	H	H	H	H	H	H	H	H	H
73	I	I	I	I	I	I	è	ノ	I	I	I	I	I	I	I	I	I	I	I
74	J	J	J	J	J	J	ò	ハ	J	J	J	J	J	J	J	J	J	J	J
75	K	K	K	K	K	K	ù	ヒ	K	K	K	K	K	K	K	K	K	K	K
76	L	L	L	L	L	L	â	フ	L	L	L	L	L	L	L	L	L	L	L
77	M	M	M	M	M	M	ê	ヘ	M	M	M	M	M	M	M	M	M	M	M
78	N	N	N	N	N	N	ô	ホ	N	N	N	N	N	N	N	N	N	N	N
79	O	O	O	O	O	O	û	マ	O	O	O	O	O	O	O	O	O	O	O
80	P	P	P	P	P	P	Å	ミ	P	P	P	P	P	P	P	P	P	P	P
81	Q	Q	Q	Q	Q	Q	î	ム	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q	Q
82	R	R	R	R	R	R	Ø	メ	R	R	R	R	R	R	R	R	R	R	R
83	S	S	S	S	S	S	Æ	モ	S	S	S	S	S	S	S	S	S	S	S
84	T	T	T	T	T	T	å	ヤ	T	T	T	T	T	T	T	T	T	T	T
85	U	U	U	U	U	U	í	ユ	U	U	U	U	U	U	U	U	U	U	U
86	V	V	V	V	V	V	ø	ヨ	V	V	V	V	V	V	V	V	V	V	V
87	W	W	W	W	W	W	æ	ラ	W	W	W	W	W	W	W	W	W	W	W
88	X	X	X	X	X	X	Ä	リ	X	X	X	X	X	X	X	X	X	X	X
89	Y	Y	Y	Y	Y	Y	ì	ル	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
90	Z	Z	Z	Z	Z	Z	Ö	レ	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z	Z
91	[	[	[	Ø	[	[	Ü	ロ	[	Ä	Ä	Æ	Ä	°	[	°	¡	Ä	Æ
92	\	√	ç	Æ	¡	¥	É	ワ	\	Ö	Ö	Ø	Ö	ç	\	ç	Ñ	Ç	Ø
93	]	]	]	ø	]	]	Ï	ン	]	Å	Å	Å	Ü	§	]	é	¿	Ö	Å
94	^	↑	^	æ	^	^	β	"	^	^	Ü	^	^	^	^	^	^	^	^
95	_	_	_	_	_	_	Ô	•	_	_	_	_	_	_	_	_	_	_	_
96	`	`	`	`	`	`	Á		`	`	`	é	`	`	`	`	ù	`	`

DECIMAL VALUE	0	1	2	3	4	6	7	8	9	30	31	32	33	34	35	36	37	38	39
97	a	a	a	a	a	a	Ã		a	a	a	a	a	a	a	a	a	a	a
98	b	b	b	b	b	b	ã		b	b	b	b	b	b	b	b	b	b	b
99	c	c	c	c	c	c	Đ		c	c	c	c	c	c	c	c	c	c	c
100	d	d	d	d	d	d	đ		d	d	d	d	d	d	d	d	d	d	d
101	e	e	e	e	e	e	Í		e	e	e	e	e	e	e	e	e	e	e
102	f	f	f	f	f	f	Ì		f	f	f	f	f	f	f	f	f	f	f
103	g	g	g	g	g	g	Ó		g	g	g	g	g	g	g	g	g	g	g
104	h	h	h	h	h	h	Ò		h	h	h	h	h	h	h	h	h	h	h
105	i	i	i	i	i	i	Ő		i	i	i	i	i	i	i	i	i	i	i
106	j	j	j	j	j	j	ő		j	j	j	j	j	j	j	j	j	j	j
107	k	k	k	k	k	k	Š		k	k	k	k	k	k	k	k	k	k	k
108	l	l	l	l	l	l	š		l	l	l	l	l	l	l	l	l	l	l
109	m	m	m	m	m	m	Ú		m	m	m	m	m	m	m	m	m	m	m
110	n	n	n	n	n	n	Ÿ		n	n	n	n	n	n	n	n	n	n	n
111	o	o	o	o	o	o	ý		o	o	o	o	o	o	o	o	o	o	o
112	p	p	p	p	p	p	Þ		p	p	p	p	p	p	p	p	p	p	p
113	q	q	q	q	q	q	þ		q	q	q	q	q	q	q	q	q	q	q
114	r	r	r	r	r	r			r	r	r	r	r	r	r	r	r	r	r
115	s	s	s	s	s	s			s	s	s	s	s	s	s	s	s	s	s
116	t	t	t	t	t	t			t	t	t	t	t	t	t	t	t	t	t
117	u	u	u	u	u	u			u	u	u	u	u	u	u	u	u	u	u
118	v	v	v	v	v	v	−		v	v	v	v	v	v	v	v	v	v	v
119	w	w	w	w	w	w	¼		w	w	w	w	w	w	w	w	w	w	w
120	x	x	x	x	x	x	½		x	x	x	x	x	x	x	x	x	x	x
121	y	y	y	y	y	y	ª		y	y	y	y	y	y	y	y	y	y	y
122	z	z	z	z	z	z	Ω		z	z	z	z	z	z	z	z	z	z	z
123	{	π	¨	ˉ	~	{	«		{	å	ä	æ	ã	é	{	à	˙	ã	æ
124	|	⊢	˙	·	~	|	□		|	ö	ö	ø	ö	ù	|	ò	ñ	ç	ø
125	}	→	ˉ	ˉ	~	}	»		}	å	å	å	û	è	}	è	ç	ő	å
126	~	~	·	·	~	~	±		−	−	û	ˉ	ß	¨	−	ì	~	˙	|
127																			